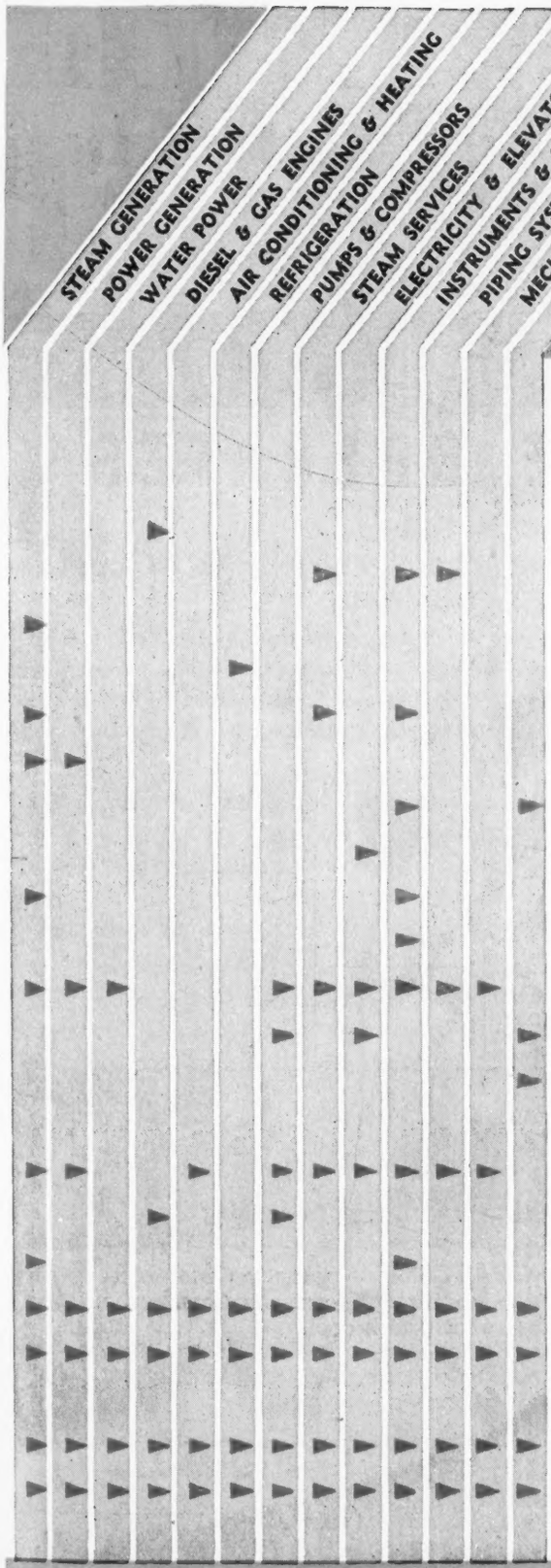

POWER

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JUNE, 1940

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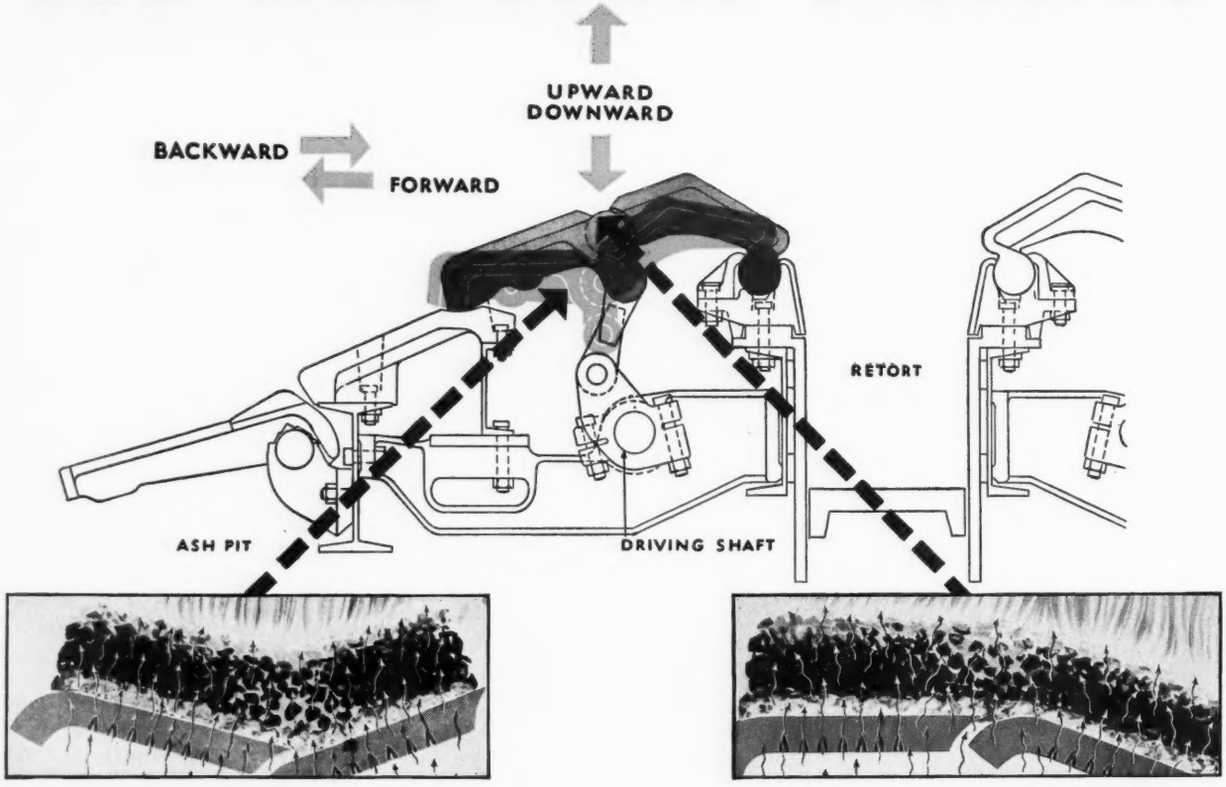
ADVERTISING PAGES REMOVED

FOR MODERATE SIZE POWER PLANTS

A SINGLE STOKER

HOW *LINK-GRATE* OPERATES



GRATES DOWN—fuel bed cracks—limits size of clinker formation.

GRATES UP—opens up fuel bed—lets air through—promotes combustion—keeps grates cool.

THE LINK-GRATE PRINCIPLE

Red and black bars above show grate positions in two extremes. This up-and-down to-and-fro motion keeps fuel bed agitated and supplied with air, keeps grates cool and prevents large clinker formation. Saves on coal and on maintenance.

Westinghouse

INDUSTRY ORGANIZES
For National Defense

ALERT to what is happening in Europe, the American people are setting out to strengthen their defenses against aggression from any quarter. Already the government has laid down an initial program to that end.

The surest defense against aggression is the ability to resist it. If we are known to be well prepared we may avert attack. If we cannot avert it we shall be armed against it. But preparedness against war means preparedness to wage war.

And modern war is an industry. Like every other industry, it is a matter of men, materials and machines. Fighting men must be skilled workers, trained to use an arsenal of special tools and equipment that are just as diversified and just as essential to success as those of any other industry.

The plant, supplies and personnel of war must rival in efficiency those of any peacetime industry. For the stakes of success or failure in war are not paid in money profits or losses: they are paid in the lives and property of the people, in the security — perhaps the survival — of a nation.

* * *

Sound national defense calls first for a comprehensive program, carefully planned to back up a clear-cut policy as to what we expect to defend. Next comes the appropriation of funds to realize that program. These first steps are vital: they are up to government.

Then program and appropriations must be translated into performance. Native raw materials must be produced, processed and stored. Our meager supplies of strategic materials of foreign origin must be built up until we have accumulated ample stockpiles against the use and wastage of active war. And most urgent, because it is most complicated, raw materials must be manufactured into the innumerable items required to equip the modern army.

We of McGraw-Hill, living with American industry as we do, are keenly aware of the effort that will be required to produce the materials and equipment now needed to modernize our national armament.

Tanks and anti-tank guns, airplanes and anti-aircraft guns, machine guns and automatic rifles, trucks and tractors, destroyers and supply ships — these are but a few items from the endless inventory of military and naval equipment that we must produce by scores, hundreds and thousands, even to arm an Initial Protective Force, behind which we might rally our national resources for decisive effort.

Obviously the army and navy must count on American industry for an ample and continuous supply of this equipment, and industry must organize to produce it in vast quantities. This means the construction and adaptation of manufacturing, transportation and storage facilities, the organization of competent executive and technical staffs, the training of skilled craftsmen in numbers adequate to maintain exacting production schedules. All this, in itself, is an industrial organization problem of the first magnitude, but upon it is imposed still another and vital specification — *sustained speed*.

For time is the all-essential ingredient of modern war. It cannot be bought with any appropriation, however great; once lost, it cannot be recaptured; we must make effective use of it while we still have it. And at this juncture we have none to waste in fumbling, jockeying or experiment.

* * *

Two courses are open to carry out such a program.

1. We might adopt the totalitarian plan of nationalizing industry, conscripting the wealth and labor of all, and suppressing the normal incentives and management of industry in favor of the authority and control of government officials.

2. Or we can stick to the American way of achieving national unity and efficiency by intelligent cooperation between industry, labor and government.

There are those to whom the first will appeal as being the more direct. But I am convinced that most Americans will insist that the job be done in the American way. And in this preference the President, speaking for government, already has indicated his concurrence.

But effective cooperation in so complex and unfamiliar a task demands the utmost of mutual understanding and confidence from all concerned. Confusion of purpose and conflict of opinion are bound to arise — have, indeed, already arisen. Needs and capacities in many fields must be reconciled, relative priorities for various products must be determined, specific parts of the whole program must be allocated, supervised and coordinated with other parts. Government officials, smarting under the whip of urgency, must render quick decisions on highly technical matters, while industrial executives, masters of their own operating technique, must adapt themselves to arbitrary and unfamiliar requirements.

Under such conditions, many problems will arise that must be worked out between the men of industry and those of government. Some of them will be the more acute because of the restrictions under which industry has had to work during recent years—restrictions that have curbed not only the expansion of plant capacity, but also the development of improved processes and the supply of skilled workers. Now, from this sag in our industrial growth, many departments of industry must undertake an overnight expansion of capacity to meet the exacting time schedules of national defense. So industry must look to government for the cooperation that will enable it to expand its facilities promptly and yet write off in reasonable time its heavy emergency investments.

* * *

If we are to deal wisely with these situations, and many more we cannot now foresee, everyone engaged in any part of the defense effort must be willing and able at all times to get a fair understanding of the problems of the others. To help maintain such an understanding McGraw-Hill is peculiarly fitted.

1. By the organized exchange of views and information among our 24 papers, we can help to coordinate the thinking and practice of the 1,000,000 executives, technicians and operating men who are their readers, in matters that have to do with their part in the defense project.

2. Through constant contact with government agencies and the men of industry, our papers can interpret to industry the needs and policies of government and to government the problems and requirements of industry.

3. For the men of industry, each of our papers will expand its regular service as a clearing house of technical and operating data, with special reference to the needs of plants that are producing defense materials and equipment.

To forward these objectives we have set up within our company a National Defense Editorial Board. It is composed of the chief editors of our publications that serve the functions and industries that are of key importance to the defense effort. Made up of men intimately familiar with the personnel and practice of their industries, this board will stimulate and supervise the activities of McGraw-Hill papers insofar as they can contribute to the defense effort. It will outline basic editorial themes, directed to the forwarding of that project, to be adapted by each paper to the special needs of its specific field.

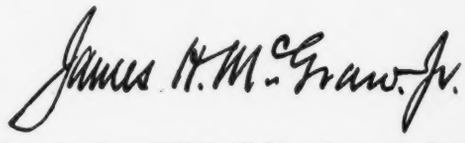
The board will keep close touch with industrial executives and technicians so as to keep abreast of new problems as they arise. It will maintain contact also with government defense agencies and keep our editors posted as to government objectives, plans and problems. Thus it will function as a link between the several governmental defense agencies and the McGraw-Hill editorial organization, and so help each editorial staff to develop a program best suited to the special problems of its industry.

* * *

In thus undertaking our part in an extraordinary industrial effort, we shall not neglect the normal concerns of American industry. So far as may be consistent with the paramount needs of national defense, production and distribution of the goods and services normally consumed by the American people must go on. The effort to mobilize industry for the national defense must be, in large measure, an additional job and an added burden.

That burden is within the capacity of the American people. But it will not be light. And if industry is to carry successfully its heavy share of that burden, it needs the full cooperation of every industrial function.

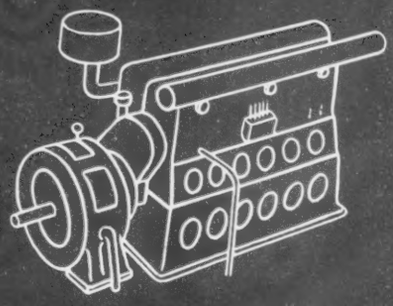
For more than seventy-five years, through peace and war, McGraw-Hill publications have served to interpret between the various departments of industry and between industry and the American people. Today, as we face these new problems, there is a new and urgent need for interpretation between the industries we serve and the government to which we all bear allegiance. It is fitting that McGraw-Hill should undertake this effort. To it I pledge every resource of our organization.



President, McGraw-Hill Publishing Company, Inc.

This message is appearing in all McGraw-Hill industrial and business publications, reaching over a million readers.

1940 Oil & Gas Power



NO MATTER HOW MUCH imagination you have, reading a mail-order catalog doesn't pack the same punch as stepping up to the counter to try the feel of a 6-oz fly rod. In a busy world we can't get along without short cuts like the catalog, but it takes a few minutes actual contact with fly rod, Stillson wrench, or whatever you're interested in buying, to put life into the factual printed pages.

In a way, POWER's annual listing of oil- and gas-engine installations resembles the mail-order bible; mighty handy to have around, full of useful information. But, like all lists, it lacks the "feel" that comes from sticking your nose into a plant's innards, the grasp of practical details that comes from chinning with the man on the job.

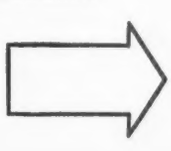
Not being able to finance a sort of Cook's tour around typical new oil- and gas-engine plants for all POWER readers, we did the practical thing. We put on our hat, grabbed a notebook and camera and hit the rails, figuring that if you couldn't get to the plants, we could bring them to you. Now, some 3000 miles and three weeks later, we bring you a living picture of diesel and gas engines on the job —eleven different jobs, to be exact.

What does the picture show, now that we've got it? For one thing, it gives concrete evidence of the versatility of diesel and gas engines, of their suitability for many specialized power jobs aside from the more or less common one of driving a generator. Thus direct engine drive becomes almost standard for cotton ginning, pipeline or water pumping, and preferred for refrigeration.

High thermal efficiency and relatively low first cost give internal-combustion engines first call in small municipal plants and in many buildings, institutions, and industrial plants where these characteristics answer heat-balance problems of long standing. Ability to burn a waste product puts gas engines in sewage-treatment plants; quick starting and low standby cost make oil and gas power ideal for emergency service.

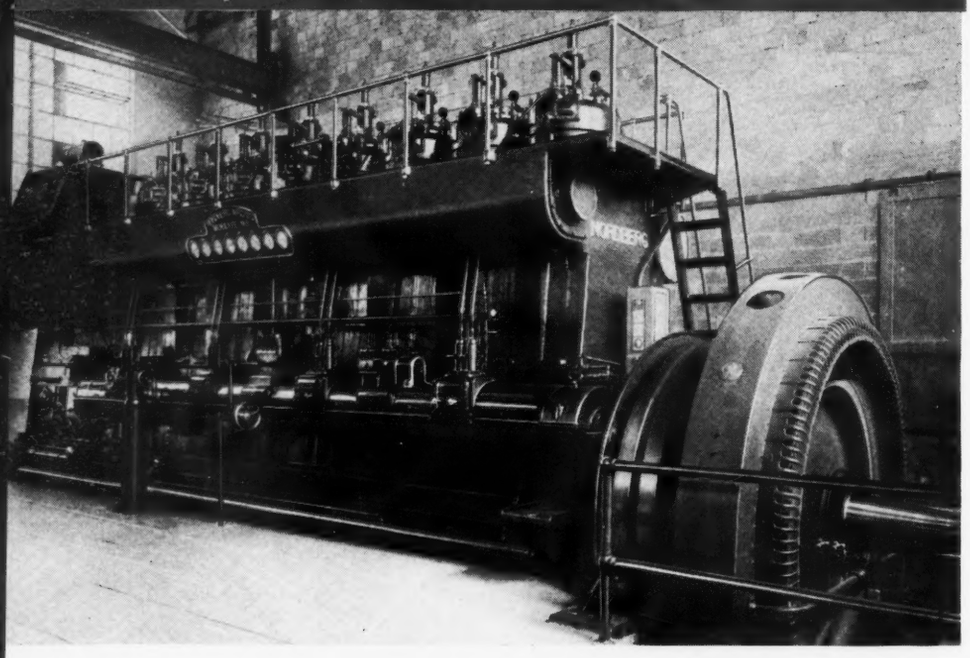
This doesn't exhaust the list by a long shot. We've just rounded up the most common internal-combustion engine applications, showing the how and the why. Every day oil and gas power proves itself in new fields, by bringing higher standards of performance and lower investment and operating costs. Will it answer your power problem?

VERSATILITY—The following 15 pages show how oil and gas engines handle industry's varied power problems



MUNICIPAL

This 1660-hp gas-fired diesel at Lubbock, Texas, was first of its kind. It saved 33% over oil-fired units in the same plant, taking advantage of low-price gas



▶ THIS YEAR'S DIESEL LIST shows that more than half of all engines over 200 hp went into municipal plants; similar ratios mark lists of past years. More plainly than words this tells the important role played by internal-combustion engines in municipal power generation.

Diesels offer advantages to the small-community plant; not only does the diesel boast highest thermal efficiency but even more important, its thermal efficiency does not suffer materially as the size of the plant decreases. So even though diesel fuel usually costs more than coal or boiler oil, the economics point to the diesel for small plants.

Although plant investment costs defy accurate comparison because of local variations, the facts seem to show that diesel plants can be built more cheaply than steam for capacities under 5000 kw. Again the advantage of the diesel increases as plant size goes down, making it a more or less obvious choice for the small community. An analysis of costs for plants of less than 10,000 kw appeared in POWER, Sept., 1938.

Because of similarity of purpose, municipal diesel plants conform more closely to pattern than do industrial applications. The typical plant houses

WATER PUMPING

▶ IN MANY PARTS of the country, oil and gas engines earn their way on diverse water pumping assignments, for water utilities, for irrigation projects, and in emergency plants for storm-water and flood control. At Oakville, Iowa, diesels serve the Louisa-Des Moines County Drainage District No. 4, and in many ways this installation represents general practice.

This farmers-cooperative organization serves a 45,000-acre rain shed. Drainage from this area and seepage from 20 miles of river front on the Mississippi and Iowa Rivers finds its way into a 250-acre lake from which the plant's two 50-in. centrifugal pumps lift it into the Mississippi against an average static head of 4 ft. About 30 years old, these pumps were originally driven by steam engines but gradual loss of efficiency and lack of adequate boiler capacity forced replacement. The first diesel, a Worthington, went into service in 1938 and the second, a Fairbanks-Morse, in 1940. Installation of both units was handled by the plant staff and a group of CCC men directed by H E Berger, camp supt, and Sam Emery, foreman.

The 4-cycle, 5-cyl, 10.75 x 14.5-in., 400-rpm, 250-hp Worthington engine drives its pump through an Allis-Chalmers multiple V-belt and also drives, by V-belt, a 2-kw generator for plant lighting. The new Fairbanks-Morse, 2-cycle, crankcase-scavenging, 6-cyl, 10 x 12.5-in., 400-rpm, 240-hp engine drives its pump through a Worthington multiple V-belt. Engine speed, on both units, is varied from 320 to 400 rpm to give pump speed of 115 to 140 rpm. A Woodward governor controls the Worthington, a Pickering the Fairbanks-Morse.

Each engine drives, by V-belt, two circulating pumps, mounted on a common shaft. One pump handles circulation in the closed jacket circuit; the other pumps raw water from the lake through a water-to-water heat exchanger, discharging back to the lake after cooling the jacket water. A Griscom-Russell exchanger serves the Worthington engine and a Schutte & Koerting the Fairbanks-Morse.

Engine Accessories

American air filters protect the intakes on each engine; the Worthington draws air from outside the plant, while the Fairbanks-Morse takes its air from the engine room. The isolated location of the plant eliminates need for exhaust mufflers. Alnor selective pyrometers check exhaust temperatures.

Fuel oil comes to the plant by truck and is stored in a 12,000-gal outdoor storage tank. Strainers on the engines protect against foreign particles in the fuel supply. The lubricating-oil system on each engine includes Purolators; consideration is now being given to

several large engines running at 225–400 rpm. Careful attention to architecture and to silencing help the plants fit into the community background. Designers and operators constantly search for ways of increasing economy and reliability of operation, so these plants make use of modern accessories and maintenance. Since the normal municipal has little use for waste heat beyond plant heating, no extensive expenditure on recovery equipment is justified, but a good number of plants salvage part of the rejected Btu's. Virtually all modern plants use double-circuit cooling; whether or not spray ponds or cooling towers are employed depends on availability and cost of cooling water.

Frequently diesels offer the best method of modernizing or expanding an existing municipal plant or can be teamed with other prime movers to provide better operating conditions. At Hillsdale, Michigan, a 6-cyl, 21 x 29-in., 225-rpm, 2-cycle, 2250-hp Nordberg diesel (see cover) went into a steam plant with a 50-year history, and a similar engine will handle future expansion. The Woodward-governor-equipped diesel drives a 1500-kw Allis-Chalmers flywheel generator operated in parallel with the turbine-driven generators. Designed to handle heavy oil, provision is made to start the engine on light oil; jacket water heats oil storage tanks and heavy-oil compartment on the engine. A small lake near the plant furnishes condensing water for the turbines and cooling water for the diesel. A double circuit with heat exchanger is used. In winter, jacket water will flow through cast-iron radiation to heat the plant.

The Sturgis, Michigan, plant described in POWER, May, 1940, illustrates diesels in combination with hydro.

Fuels for Municipals

Fuel used in municipal diesels depends largely on local market conditions. To take full advantage of price fluctuations in areas where both oil and gas are available at competitive prices, many municipals provide for a quick change from one to the other by installing convertible engines or the new "gas-diesels". In the latter, gas is burned on the full diesel cycle, with some pilot oil to stabilize ignition. Experience at Lubbock, Texas, outstanding municipal application of these engines, shows them easier and cheaper to operate and maintain than diesel oil engines of the same make, and sensitive to load changes. In this particular plant, operation on gas saved about 33% over oil. Since the original installation in 1936, others have gone into service in the Southwest and this year's list shows another unit for Lubbock—an 8-cyl, 21 x 29-in., 225-rpm, 3200-hp Nordberg.

Where only oil is available, many municipals save by use of engines able to handle heavier grades, often purchasable at extremely low prices. This kind of buying is one of the reasons behind the unusual record of the Ponca City, Okla., plant, where for 10 years, four 1250-hp air-injection engines have burned oil ranging in price from 0.95 to 1.81 cents per gal. Average performance on this fuel runs 10 kwhr per gal. of fuel oil and 2250 per gal. of lube oil, with maintenance at ⅓ mill per kwhr. Data on this 10-year record will be found in POWER, May, 1938.

For performance and descriptive data on other typical municipal plants, see "Diesel-Powered Community," POWER, Jan, 1937; "Power for Navajos," Aug, 1937; "Gas-Fired Diesel," Sept. 1937; "Municipal Chooses Convertible Engines," Sept, 1939; "Hawkeye Horsepower," March, 1937.

adding an oil reclaimer. Pittsburgh meters on each engine-supply line give a record of fuel-oil consumption.

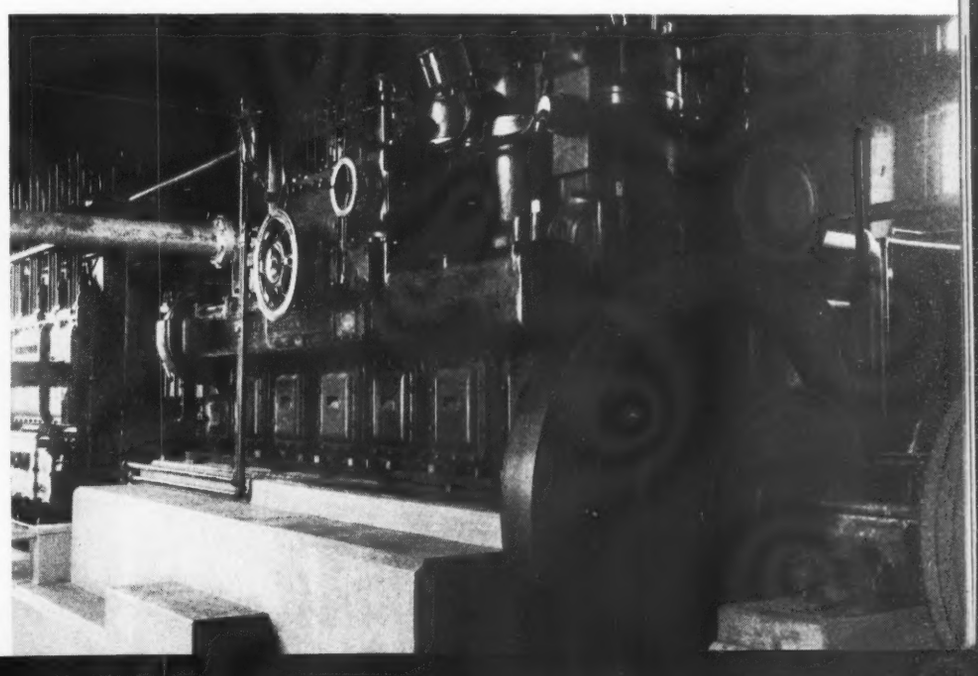
Other plant auxiliaries include a Worthington starting-air compressor driven by a Novo gasoline engine, and a Nash vacuum pump for priming, connected to a Continental gasoline engine.

Drainage plants of this kind, scattered along the river, are run by farmer-cooperative organizations but are under government supervision. Operators must keep accurate records of river stage, rain fall, fuel-oil and gasoline, and maintenance costs. Total cost of operation is expressed in terms of cents per acre-foot of water handled, to permit comparison of the performance of different plants. Installation of diesels at the No. 4 plant brought costs down from about 40 cents an acre-foot to 16.1, the best record in the Rock Island district. Average for other diesel plants runs about 20 cents per acre-foot, ranging up to 30 cents for steam and about 40 cents for electric drive using purchased power. These figures are, of course, only averages, and the performance depends to a great degree on the amount of water pumped. However, they show the suitability of the diesel to a steady-load application where lack of possibilities for waste-heat utilization puts a premium on prime-mover efficiency. At the No. 4 plant, recent establishment of a 9-foot channel in the Mississippi increased the pumping load so that engines run steadily for practically the entire week.

The Louisa-Des Moines County Drainage District No. 4 plant is under the supervision of Fred Enz; Ed Yotter is chairman of the board. Stanley Engineering Co, Muscatine, Iowa, was consulting engineer for the addition.

For data on application of oil- and gas-engines to other water-pumping jobs, see "Gas-Engines Take on a New Job," POWER, April, 1940; "Pumps Against the River," Oct, 1939; "Diesel-Pumping Bay-State Water," Feb, 1938.

These diesel-driven pumps at the Louisa-Des Moines County Drainage District No. 4 show lowest average power cost in Rock Island area



COATING MILL

▶ The Appleton Coated Paper Co, Appleton, Wis., found a diesel to be an economical way to meet growth in electrical load that had outstripped demand for steam. At this plant, paper, bought from other mills, is finished with a glaze or colored coating. The only steam needed for the process goes to hot-water heating and drying.

The original plant consisted of a 4120-sq-ft Kidwell boiler and a 4400-sq-ft B&W, fired by Combustion Type E stokers, supplying steam to a 20x32-in. Nordberg poppet-valve steam engine. This unit ran at 4-5 lb back-pressure, furnishing steam for building heating, for heating mill water and for drying. Part of the load increase was met by stepping up boiler pressure and superheat (to 180-195 lb, and 125 F superheat). This increased engine capacity from 450 hp to about 600 hp.

In 1936, an Allis-Chalmers condensing turbine was installed, driving a 150-kw generator through a 5000/1200-rpm Falk reducing gear. Cold water from a deepwell supplies the condenser. This addition helped but in a short time more electrical capacity was needed. Choice simmered down to building a new boiler house and adding another turbine, or buying a large diesel. From several angles, the latter proved the best bet. By avoiding extensive boiler-house alterations, it kept first cost down; and since delivered cost of fuel is high, the diesel offered greater operating economy for straight power generation.

The new unit, a 16.5x24.5-in., 5-cyl, 257-rpm, 625-hp, Busch-Sulzer engine, drives a General Electric generator and, through a Morse drive, an exciter. A Woodward governor controls frequency and a Curtis compressor with Crocker-Wheeler motor provides starting air. An addition to the power house building houses the engine, accessories, and new GE switchgear.

A Viking pump, driven by Crocker-Wheeler motor, transfers oil from tank cars to three 10,500-gal underground tanks, and a smaller similar unit pumps from tanks through a Sentinel filter to the day tank. Oil flows from the day tank through a twin strainer and through a Purolator unit, to the engine. Another Purolator unit keeps lube-oil clean and a Hilco oil reclaimer is installed. A Nathan lubricator supplies cylinder-wall feed.

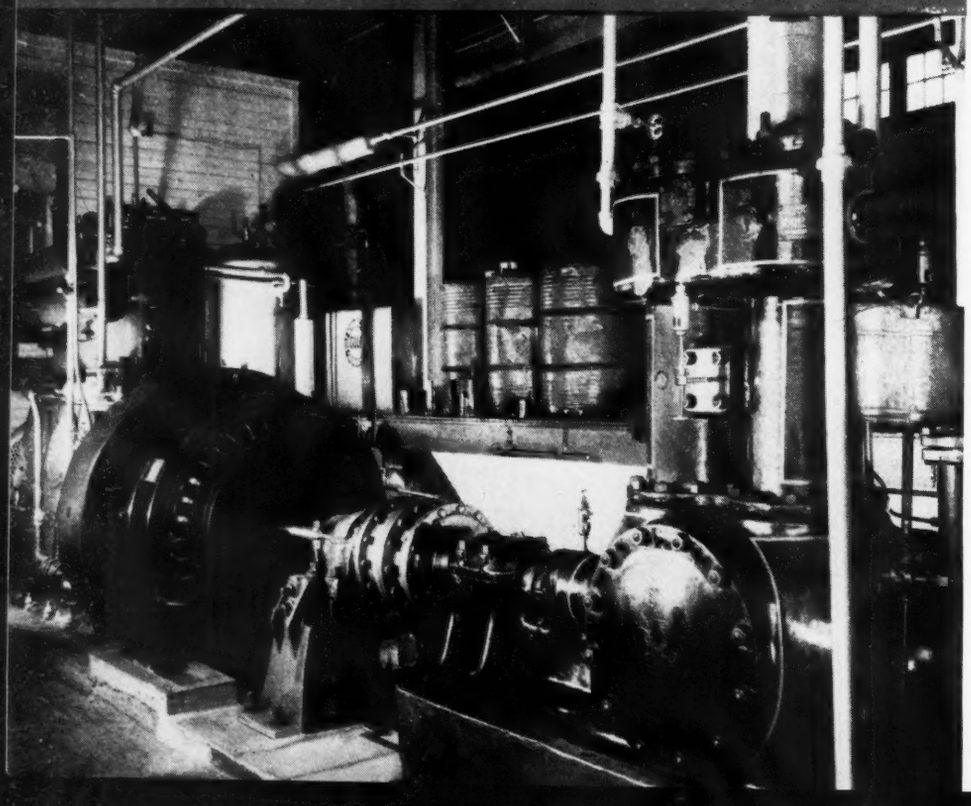
Waste-Heat Recovery

An American air filter, mounted outside the building, cleans intake air. Exhaust gas passes directly into a Foster Wheeler waste-heat boiler and then out a tall vent pipe. Since engine load is variable, a constant supply of mill water passes through the waste-heat boiler to pick up all heat available, and then goes to an exhaust-steam heater to be raised to the desired final temperature. An Alnor pyrometer checks diesel exhaust temperatures.

This mill water comes from the same

REFRIGERATION

Atlas-Imperial diesel in Harrisburg, Pa., ice plant promises to halve power costs



▶ When ice was made from distilled water, steam represented the logical source of power. Development of raw-water ice making, now almost universal, eliminated the need for steam and gave the edge to other prime movers. For a time, electric-motor drive, using central-station power, held sway, but in recent years oil and gas power has come to the front, particularly in the smaller plants. The reasoning behind the installation of a diesel at the W E Hoffman Ice Co, Harrisburg, Pa., is typical.

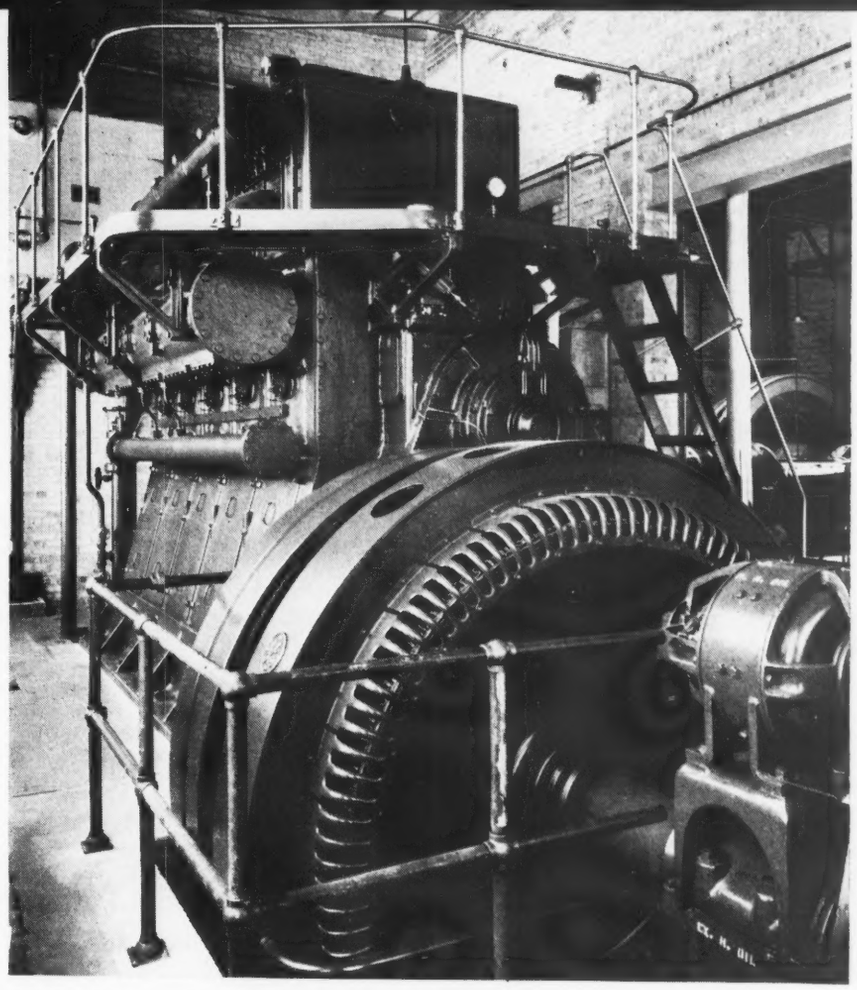
When William Mundhenke, with wide experience in operating ice plants, took over this 10-year-old enterprise, he realized that production costs must come down to meet today's competitive conditions. The 9x9-in. York compressor was then driven by a synchronous motor, and electric power represented a major item of cost.

As is common, the plant enjoyed a low off-peak rate (about $0.015 per kwhr), but current consumed during daytime hours (7:00 AM to 7:00 PM) came under a different rate, costing about $0.04 per kwhr. To get full advantage of the low off-peak rate meant working a night shift to handle

well that supplies circulating water for the condenser, but all mill water is softened in a Permutit zeolite unit and stored in two 40,000-gal underground tanks. Jacket-water is drawn from the same tank as the water going to the exhaust-gas heater, and after circulating through the jackets returns to the tank. In case water to the jackets runs higher than 110-F, as is likely in the summer, a Marley atmospheric cooling tower will provide cooling effect.

Normally, the diesel and steam engine divide the load so that there is enough exhaust steam for process purposes. With either of these large units out of service, the turbine comes into action, but only provides enough capacity to carry the plant on restricted operation. The engine has only seen three weeks service, so no savings record is available. However, Marin Phillips, power engineer, is pleased with the showing made in short economy tests.

Other large-scale industrial applications of oil and gas power were described in these POWER articles: "A Gas-Engine Steam Generator," Nov, 1937; "Macy's Installs Another Diesel," Aug, 1937; "New Diesel Plant, New Cooling Method," July, 1938.



Teamed with steam, this Busch-Sulzer diesel meets growing power load economically

the bulk of the freezing, and in summer, with full 24-hr operation, a major part of the load fell unavoidably in the high-cost brackets. Under these conditions, power costs ran about $0.90-1.00 a ton.

To reduce costs, Mundhenke bought a diesel, which was installed in January of this year. By being able to control hours of operation, the plant can be run on an 8-hr-day basis all winter, saving a night shift during about six months of the year. Burning No. 4 oil, at 6.5 to 7 cents per gal, he expects to cut his power costs to 40-50 cents per ton of ice, or roughly in half. On this basis, the engine installation will pay for itself in 3 to 5 years, depending on the volume of ice production.

Although a conversion, the installation represents typical ice-plant diesel practice. The bulk of the load is the compressor and, since reciprocating-compressor speeds closely match average diesel-engine rpm's, direct drive is customary. In addition to this load, the engine must supply power for lights and auxiliary motors. It is common practice to belt or direct-connect a generator to the engine for such service. In this case, the existing synchronous motor was utilized. Utility service supplies current for lighting when the engine is shut down.

The new 3-cyl, 10x13-in., 300-rpm, 96-hp Atlas-Imperial engine drives the synchronous generator and the compressor directly, with a Fasts flexible coupling between generator and compressor. Intake air comes from the engine room, through a Vortox filter, and exhaust passes out through the roof, with a Maxim silencer to muffle the noise. An Alnor pyrometer checks cylinder exhaust temperatures, and a gasoline-engine-driven Atlas compressor supplies starting air.

Oil Handling

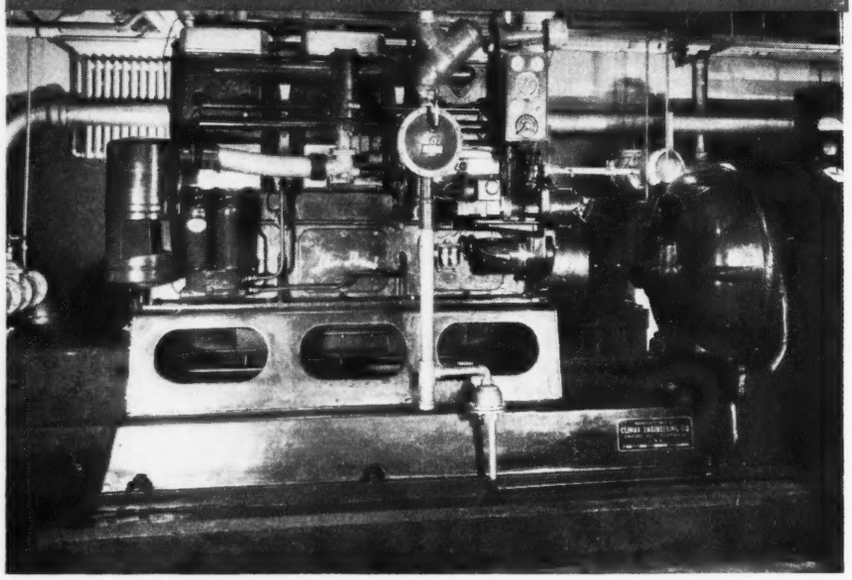
A temporary 200-gal tank handled small winter needs adequately but by summer a 5000-gal underground tank will have been installed. Strainers in the 15-gal day tank and on the engine keep fuel oil free from impurities. In addition to the Purolators mounted on the engine, a reclaimer will be installed to remove sludge and oxidized carbon from the lube oil. With this arrangement and with careful operation, Mundhenke believes lube-oil costs can be brought down to 1.5 cents per ton of ice (a good figure), and heavy maintenance postponed almost indefinitely.

Installing a diesel in an ice-plant usually involves little or no additional equipment for jacket-water cooling, since the engine can be tied into the existing condensing-water system. In this plant, water from the vertical shell-and-tube condensers reaches the engine at about 80-90 F, leaving at about 120 F. The existing spray pond on the plant roof has ample capacity to handle the extra heat load imposed by the diesel, and condenser pressure has not increased noticeably.

This 25-ton plant typifies the many small ice plants where direct diesel- or gas-engine drive pays dividends. Larger plants will differ only in that more elaborate equipment is justified. Oil and gas engines also find wide use as direct drives for compressors and in other plants where refrigeration or air conditioning is required. The following articles in POWER show typical applications: "No Btu's Lost in Dieselized Dairy," Jan, 1940; "Sears Conditions with Gas," Oct, 1937; "Double-Duty Gas Engines at Knudsen Creamery," Oct, 1939; "Crankless Diesels for Ice Plants," Feb, 1937; "Gas Makes Ice in Dallas," Dec, 1937.

SEWAGE DISPOSAL

At Davenport, Iowa, this 75-hp, 6-cyl, 720-rpm Climax engine converts sewage gas into useful power; a similar unit drives the main sewage pump



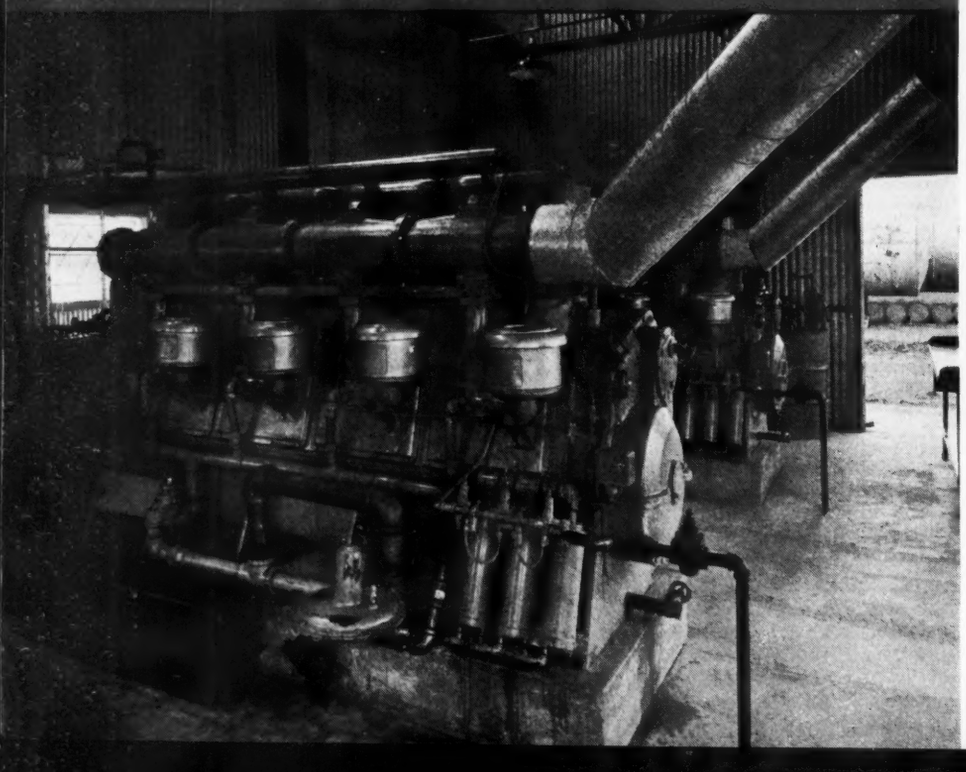
▶ SUCCESS IN OPERATING an engine on sewage gas at Charlotte, N. C., in 1928, first American installation, opened a new field of usefulness for gas power. Burning a waste product to make cheap power lowered the cost of sewage disposal and so helped pave the way for the recent widespread adoption of scientific sewage treatment in communities all over the country. Gas-engine power units fit the picture particularly well in small plants such as that at Davenport, Iowa.

Here, a primary sedimentation system is used (see POWER, April, 1939, for a description of the more complicated activated-sludge aeration process at Tallmans Island, N. Y.). Raw sewage goes first to a comminutor which reduces size of particles, and then is pumped to a grit chamber where inorganic solids are removed. From there, sewage goes to three settling tanks where it stands from 1½ to 3 hours, depending on the flow, which varies from 15 mgd to 4 mgd. Here the solid organic material settles out, and the highly dilute liquor flows out into the river. Other pumps force the sludge into digestion chambers where, at a temperature of about 85 F, the organic materials ferment to form sewage gas. The sludge that remains is pumped to a mechanical filter or to outdoor drying fields and can be sold as fertilizer or used as light fill.

The gas formed runs about two-thirds methane and one-third CO_2, with traces of oxygen and illuminants. At Davenport, the heating value averages 700 Btu per cu ft. A 4-in. main carries the gas to the main control building.

PIPELINE

At Cheney, Kansas, these 900-rpm Sterling butane engines drive, through 4:1 speed increasers, 4-stage pumps (on other side of partition)



▶ AS PIPELINES SPREAD across the country, carrying oil, natural gas, gasoline and other products to points of consumption, more and more internal-combustion engines have gone into service along the lines, driving the pumps so necessary to these operations.

Until 10 years ago, standard practice involved slow-speed diesels and reciprocating pumps. Before the first gasoline pipeline pump was built, a few centrifugal pumps (running first at 1800 rpm and later at 3600) had been tried on crude-oil lines to reduce investment cost. This meant gearing between slow-speed engine and high-speed pump.

When the Phillips Petroleum Co started to design a long gasoline line, the major problem was to hold down leakage and evaporation losses. The answer was use of centrifugal pumps on a closed system in which all stations were boosters and in which it was unnecessary to run gasoline out into tanks at each station.

Aiming at high efficiency and low investment, designers checked the pos-

Since gas generation and gas consumption do not always match, a surge tank floating on the gas line and a spherical gas holder are provided. If pressure in the surge tank builds up to 4-in. H_2O, indicating excess supply, an automatic switch starts up a compressor which pumps gas into the holder. When surge-tank pressure drops to 3 in., the compressor stops. Gas can be stored in the holder until 48 lb per sq in. pressure is reached, at which point the sphere holds 58,000 cu ft. Any excess over what can be used and what can be stored passes to a waste-gas burner.

Gas from the digester goes to a 4-in. header, in the main control building, which supplies the two engines and a gas-fired boiler. If rate of generation falls below rate of use, so that pressure in the gas line to the header drops below 2 in., gas flows into the system from the holder, through a pressure-regulating station. A natural-gas line, from the city system, ties into the header, for use when no sewage gas is generated. Meters measure sewage gas used and wasted, and city gas.

The biggest power load in a plant of this type is the main sewage pump; in this case a single 75-hp, 6-cyl, 720-rpm Climax engine drives the pump directly. Another similar engine drives a Fairbanks Morse shunt-wound generator supplying power for auxiliaries and lights. Central-station power service handles minimum needs when the sewage engines are shutdown.

Each engine has a piston speed of 840 fpm and rated BMEP of 70 lb. Guaranteed fuel consumption at full load is 10,000 Btu per bhp hr; this rises to 11,000 Btu at ¾ load and 13,000 at ½ load. Each unit has a Peerless governor and American-Bosch magneto system. An Ensign dry filter removes foreign matter from the gas supply, but operation shows this gas to be clean and free from corrosive constituents such as H_2S. Each engine also carries a filter for lube oil; without other means of treatment, consumption runs about 3000 rated hp hrs per gal. An Air Maze filter protects the air intake and Maxim silencers muffle exhaust. Engines are equipped for electric starting.

Heat Recovery

Recovery of jacket-water and exhaust heat supplies most of the Btu's needed for keeping the digestion tanks at about 85 F, the best temperature for fermentation. A closed jacket system with built-in pumps circulates distilled water to keep jackets scale-free. Water in this circuit leaves the jackets at about 158 F and picks up additional heat in an exhaust-gas exchanger before entering a water-to-water exchanger at about 169 F. Two Fairbanks Morse circulating pumps used alternately force return water from the digesters through the water-to-water exchanger. There the water picks up enough heat to raise temperature from about 90 F to 120 F. Jacket water returns at about 140 F.

The sewage-gas-fired boiler supplies 180-F water for building heating and serves as standby in case engine waste heat isn't adequate to keep water flowing to the digesters at 120 F. Thermostatic 3-way valves take care of this automatically, and also bypass part of the hot-water to the sewer and admit cold city water, if water temperature to the digesters exceeds 122 F. This system takes care of variations in digester heating requirements due to seasonal fluctuations and to differences in amount of sludge pumped to digesters.

Under normal conditions, sewage gas provides all power and heat requirements of the plant, producing an important saving in operating costs. Operation of the plant is in charge of John Strelow, superintendent, under the general supervision of R C Graham, Supt of Public Construction. Consoer, Townsend and Quinlan, of Chicago, were the consulting engineers.

sibility of using the cheaper and simpler gas engine, as gas fields and pipelines are numerous in the West. Everything pointed to high-speed engines to reduce the step-up ratio in the gearing and so bring down cost. The Sterling Viking engine, running at 900 rpm, met the need for a reliable high-speed prime mover to burn natural gas or butane.

The Phillips station at Cheney, Kansas, is typical. Three 8-cyl, 8x9-in., 900-rpm, 400-hp Sterling engines are direct-connected to 4:1 speed increasers, the high-speed shafts of which direct-connect, in turn, to 3600-rpm, 4-stage pipeline pumps. The line handles approximately 40,000 barrels per day of gasoline (refinery and natural) and butane. Fuel (butane) for the engines is taken from the line at intervals and stored at the plant, or natural gas is purchased.

Two battery-powered electric starters on each engine can bring the entire unit (engine, gear and pump) up to speed. The starting batteries supply a dual ignition system that includes two distributors, two interruptors and four sparkplugs per cylinder. This insures better firing and decreases shutdown time due to dirty sparkplugs or ignition trouble. Four carburetors give proper fuel distribution and keep consumption to a minimum. The engines operate at piston speeds of 1350 fpm with BMEP of 73 lb per sq in., and have run successfully with BMEP's as high as 95 lb per sq in.

Engine Mounting

A continuous concrete slab supports engine, gear and pump. The latter two are mounted on a common bedplate with a flexible coupling connecting their shafts. A resilient coupling connects engine stub shaft and gear. Critical vibrations are eliminated in the range from 700 to 1000 rpm and operators can run any unit at various speeds to maintain correct suction and discharge pressures.

Generators V-belted to engine shafts and a small engine-driven auxiliary generator supply power for auxiliary pumps and lighting. Each engine has its own lubricating system, consisting of a scavenging pump taking oil from the engine base through a filter and back into the base. A second pump forces filtered oil through the complete engine pressure system.

In many pipeline installations, pumped gasoline was used as engine coolant, being circulated through a large heat exchanger to cool soft water in the closed jacket circuit. Part of this water was bypassed through a small cooler for the gears. Such heat exchangers raise the temperature of gasoline in the pipeline by about 10 F, and later it seemed advisable to use small cooling towers.

Installations of this kind were made at stations between Borger, Texas, and St. Louis, Mo., and on a branch to Kansas City. Well water in these plants turned out bad for cooling, although use of water softeners helped. The biggest aid was providing station buildings with complete sets of gutters. Now, rain water is piped to tanks, and as only a few barrels of makeup water per day are required, this storage system supplies over 90% of the water used in the closed system.

OFFICE BUILDING

▶ IN OFFICE BUILDINGS and similar plants, the big problem is to make summer economy approach that of winter when use of exhaust in the heating system permits byproduct-power generation. Chief Engineer Frank R Daly, of the Minneapolis Chamber of Commerce Buildings, believes the solution lies in combining steam and diesel.

The Chamber of Commerce Buildings are the home of the Northwest grain trade and also the largest cash grain sample market in the world. The main building houses the home office of General Mills, world's largest millers. Started in 1904, the original power plant contained 5 hand-fired Scotch marine boilers, two Westinghouse vertical engines and a duplex-compound American Ball unit.

Disappointing results during four years' operation led to contracting for purchased power, but after 10 years, two Erie City Iron Works Lentz poppet-valve engines (200-kw and 300-kw) were installed and private generation resumed. Adding a 400-kw Ridgeway compound engine in 1929 permitted dropping a 200-kw utility service for night, Sunday, and standby loads, and since that time the plant has been entirely on its own. The present boiler plant consists of the original 5 Scotch marine boilers (1500 sq ft each) fitted with Jones underfeed stokers, and a 3000-sq-ft Scotch marine boiler fired by a Strong-Scott pulverizer unit.

Use of diesels gives the answer to the old question of "heat balance". The steam engines carry just enough load to supply the 2-pipe vacuum-heating system. Radiators in the offices are equivalent to an air-cooled condenser, and there are few days when there is less than 10-in. vacuum on the engines. Exhaust from the steam vacuum pump goes to hot-water heating tanks; part of the engine exhaust raises feedwater temperature to about 200 F. The boilers also supply some live steam (135 lb) to tenants for cooking, etc.

The Chamber bought its first diesel in 1937, a 4-cyl, 17.5x24-in., 225-rpm, 400-hp De La Vergne. Although cylinder heads are less than 6 ft from the building's first working floor, no one complains of noise or vibration. Engine accessories include a Manzell lubricator, Alnor pyrometer, Goulds lube-oil centrifuge, and Air Maze intake filters.

Another engine, a 3-cyl, 12.5x15.5-in., 400-rpm, 300-hp De La Vergne, went into service last year. Its foundation block rests on Korfund vibro-dampers and felt, to isolate vibration. This unit has a Woodward governor, a Schutte & Koerting oil cooler, Purolators on both lube- and fuel-oil circuits, and Burgess intake air filter.

An ingenious arrangement recovers exhaust heat from both engines; gas from each passes into a boiler combustion chamber to generate hot water. Distilled water circulating through jackets and a heat exchanger, cools the engine. Raw well water goes through

COTTON GIN

▶ THE PRESENT-DAY, highly-perfected cotton gin requires about 130 hp in the main drive and usually a small unit to drive a fan for unloading cotton from the farm wagons. In an overbuilt industry with keen competition, the gin operator needs low power costs to survive. The old slide-valve steam engines supplied by simple fire-tube boilers have almost entirely given way to electric power and economical internal-combustion engines burning fuel oil, natural gas, distillates, or butane.

Natural gas is preferred where available; otherwise the choice may be a diesel, provided reliable fuel is to be had at good prices. Although a little more costly than other liquid fuels, operators favor butane for clean and trouble-free operation. Running with natural gas or butane means no crankcase contamination or carbon deposits and operators report less wear of liners and longer intervals between ring replacements and overhauls.

Butane prices range from 4.5 to 8 cents per gal, gasoline from 5.5 to 8, distillates from 3.5 to 6, and fuel-oil about the same. Natural gas may run as low as 40 cents per 1000 cu ft. A typical operation requires 1100 cu ft of natural gas, 11 gal of butane, 10 gal of gasoline or 7 gal of diesel oil, to produce 100 bhp hr.

Power cost in terms of cents per bale may be misleading, as consumption may vary from 15 kwhr per bale to 50, depending on the condition of the cotton and the ginning equipment, and since the number of bales ginned per hour and other operating factors affect cost markedly. However, some diesel-driven plants report costs as low as 7.5 cents per bale, while costs in plants using natural gas, butane, or distillate may run around 10-25 cents. As the seasonal cotton-gin load is not desirable for utilities, rates rarely get below 2.5 cents per kwhr, making cost with electric drive vary from 30 cents to as high as 75 cents or $1.00 per bale.

Typical Power Setup

The Yates & Crowley gin at Atlas, Texas, represents a typical power setup. Here a 6-cyl, 6.75x7-in., 900-rpm, 130-hp LeRoi gas engine drives a Hardwicke-Etter gin with full cleaning and extracting equipment. The plant is in a small village where natural gas is not available, so uses butane as fuel. This consists of 50% butane, 30% isobutane, and 20% propane. It averages 93,200 Btu per gal, and weighs about 4.7 lb per gal.

Compression ratio for this fuel is 6.5 to 1. Low-grade 65-octane gasoline, running about 117,220 Btu per gal, and

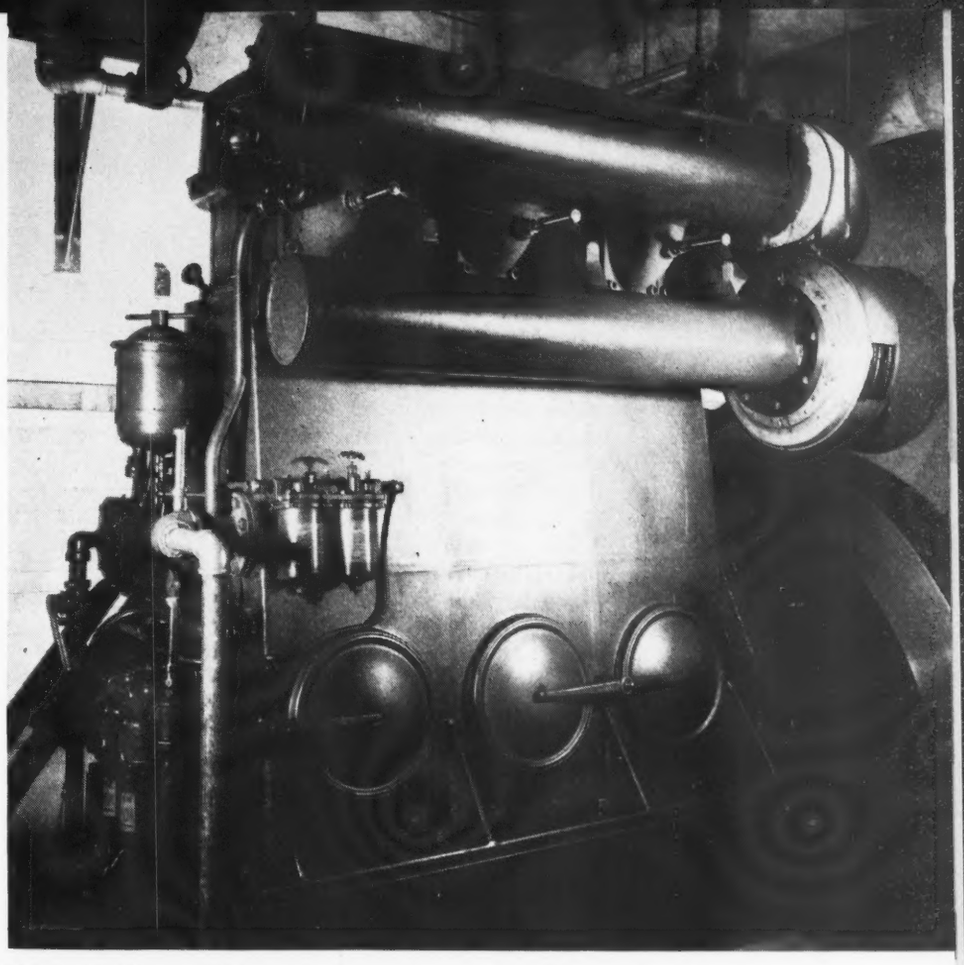
the heat exchanger to the sewer. Maxim silencers muffle both exhausts.

A comparison of the first 6 months of the 1939-40 fiscal year with the same period in '36-'37, when there were no diesels in the plant, shows that 158,780 additional kwhr were generated while fuel, labor and maintenance costs were all reduced. This figures to about $7500 for the 6 months. On this basis, the engines will pay out in 4 to 5 years.

Long-Time Gains

Improvement in operation over a long period is even more interesting. From 1904 to 1939, the Chamber added 41% to the cubic contents of the buildings to be heated and lighted. A gain of 313% in kwhr was met with 25% *less* fuel and no added labor. In 1904, a kwhr cost 19.4 lb of coal; in 1910, 18 lb; in 1920, 15.9 lb; in 1930, 9.2 lb; and in 1939 it had dropped to 3.4 lb per kwhr. (Fuel-oil is converted to equivalent coal for comparative purposes, since steam engines handle the bulk of the load.)

For other examples of diesel and steam combinations in office buildings see "Bank Balance," May, 1937; "Skyscraper Adds Diesel," June, 1935; "18 Months With Diesel," Dec, 1936.



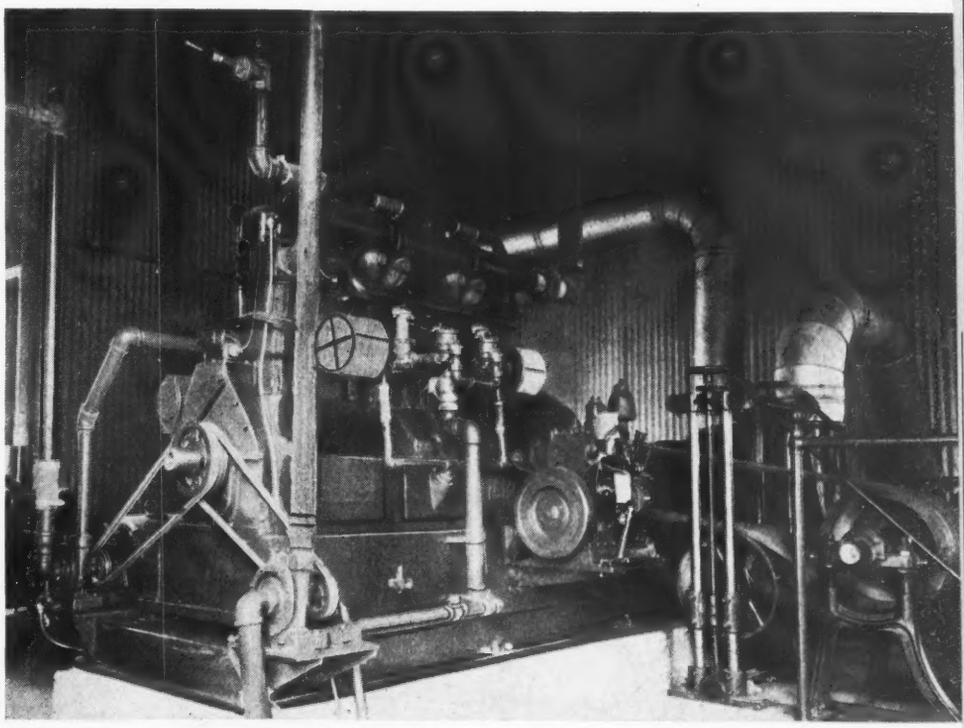
This 3-cyl, 400-rpm, 300-hp engine is one of two De La Vergne diesels improving heat balance at Minneapolis Chamber of Commerce Buildings, Minneapolis, Minn.

about 6.15 lb per gal, could also be used at a compression ratio of 5.3 to 1. Output with butane runs about 18% higher than for gasoline, due to higher compression ratio and BMEP.

The dry-sump engine, with water-cooled exhaust manifold, drives through a Texrope drive with Hardwicke-Etter idler, providing short centers, and pulleys and sheaves of small diameter. Auxiliaries on the engine include Purolator filters for lube-oil, a Johnson valve to cut off fuel if lube-oil pressure falls, an Air-Maze intake filter, a Maxim silencer, and Gould cooling-water pumps. The closed-circuit cooling system is equipped with a thermo-control valve and a Penn switch connecting to an alarm.

An Ensign heat exchanger utilizes hot water to vaporize and mix the butane; heat exchanger and mixing unit are outside the building in accordance with underwriter's requirements.

The 1940 and previous gas- and diesel-engine tabulations show the wide variety of fuels used in internal-combustion-engine drives for cotton gins.



Using butane as fuel, this LeRoi, 6-cyl, 900-rpm, 130-hp gas engine, with multiple V-belt drive, powers the Yates & Crowley cotton gin at Atlas, Texas

EMERGENCY

► LOW STANDBY COST, quick starting, and reliability make internal-combustion engines prime favorites for emergency power service. Recent natural disturbances such as the 1938 hurricane, spring floods, and last winter's blizzards and ice storms have emphasized the need for protection of vital power services where lives and health are at stake and, in many cases, the dollars-and-cents wisdom of providing against complete shutdown of continuous industrial processes.

Installations range from small self-contained sets with diesel, gas or gasoline engine, generator, accessories and controls mounted on a single subbase, to larger engines with separate auxiliaries. Mass production continues to bring down the cost of the self-contained "packaged-power" units and they represent the cheapest and simplest solution where large quantities of power are not required.

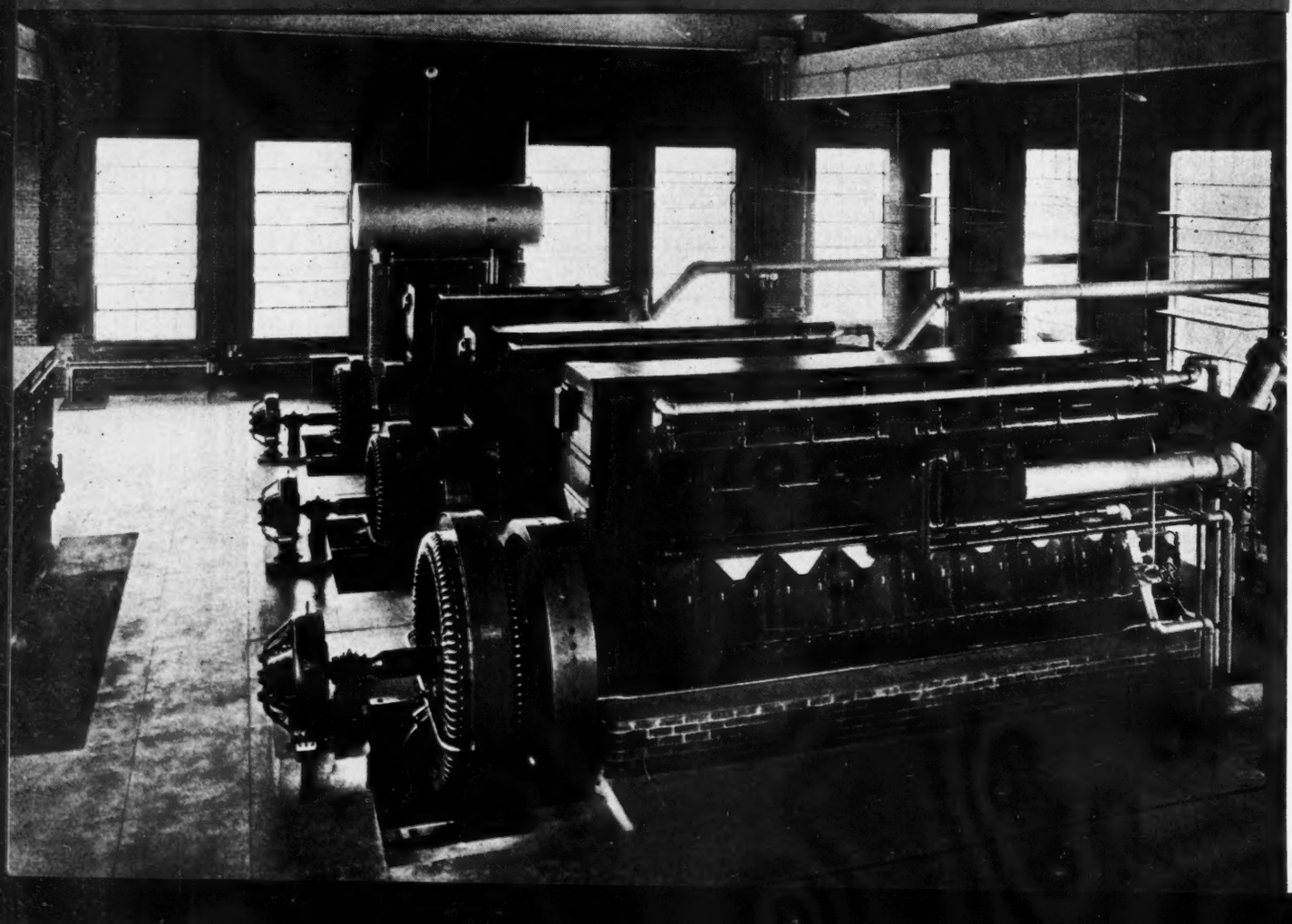
In larger installations, engines and auxiliaries are conventional, but every effort is made to reduce first cost without sacrificing reliability. For occasional emergency operation, economy in use of cooling water and waste-heat recovery play no part so that jacket-water and exhaust circuits may be highly simplified. Typical large standby units are those being installed in telephone exchanges in many parts of the country (see POWER, June, 1938, for a brief description of such a unit). The accompanying installation table lists an unusually big standby unit, the 8-cyl, 12.5 x 13-in., 650-rpm, 780-hp American Locomotive engine at the New York Telephone Co headquarters.

The emergency diesel at the National Art Gallery, now under construction in Washington, D C., represents a somewhat unusual application. This monumental building stands in a part of Washington subject to flash floods from the Tidal Basin. Clyde R Place of New York, consulting engineer for the project, designed the foundations to withstand such conditions and because of the nature of the buildings, exceptional precautions were taken to leave no loopholes for trouble in case of a flood. The emergency diesel is one of these precautions.

A 3000-gpm, vertical, non-clogging, Economy pump, driven by a 50-hp, 680-rpm Westinghouse motor, drains the main sump. Through a right-angle-gear

INSTITUTION

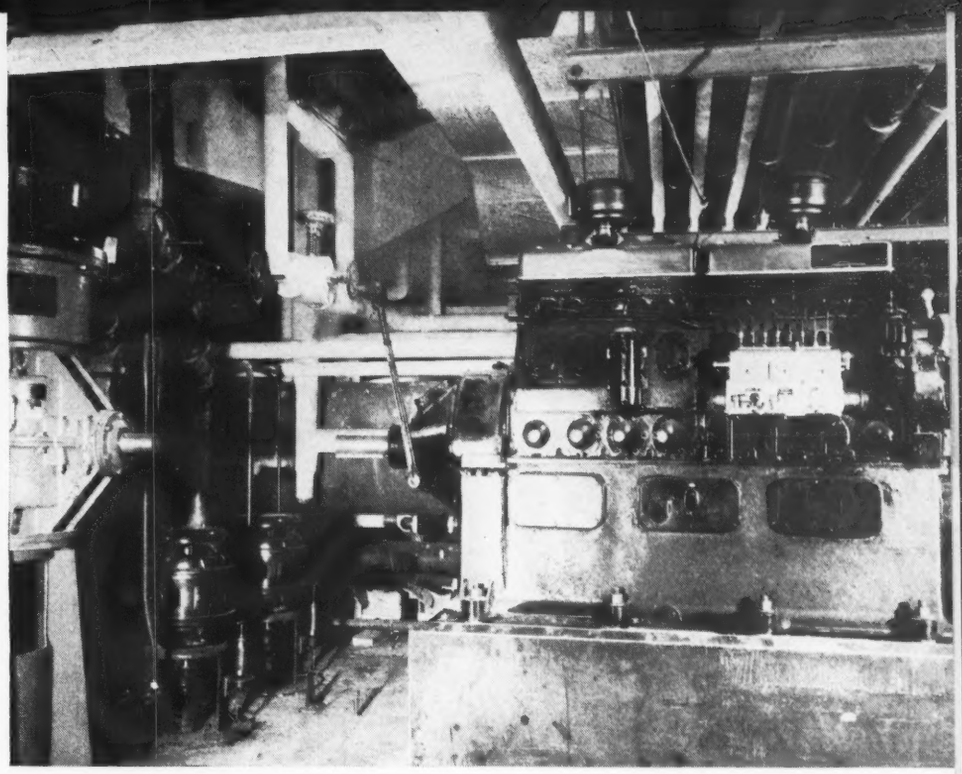
Capable of burning either gas or diesel-oil, these convertible engines produce low-cost power at Texas State Prison, Huntsville, Texas



drive, and Twin Disc clutch, the 8-cyl, 4.5 x 5.75-in., 900-rpm, 63-hp Superior diesel can drive the pump if motor power supply fails. The engine also drives a 5-kw, 208-volt, 3-phase, 60-cycle Westinghouse generator for emergency lighting.

The engine is fitted with Maxim intake and exhaust silencers and Air Maze intake filter. A Willard battery provides quick electric starting. A Puralator protects the lube-oil circuit and Sundh alarms guard against low oil pressure or high water temperature. Main fuel supply comes from a 1500-gal underground tank outside the building; a Viking oil-transfer pump keeps a small day tank near the engine full at all times. The engine exhausts through a building vent stack.

Jacket-cooling water comes from the city supply system, through a reducing valve, and goes overboard to the sewer after use. In addition, a connection from the sump-pump discharge line permits cooling the engine with flood water in case of necessity.



When the National Art Gallery, Washington D. C., is completed, this Superior diesel will standby to drive the flood-control pump, at left and a 5-kw emergency-lighting generator to be mounted on the foundation at the right. The 3000-gpm pump, fitted for direct motor drive or right-angle diesel drive, drains the main sump

▶ WHERE BOTH NATURAL GAS and diesel oil are available at comparable prices, convertible engines or "gas-diesel" units offer the great advantage of fuel flexibility, permitting efficient operation with whichever fuel is cheaper. Convertible engines totalling 1530 hp supply all power and light requirements of the Huntsville unit of the Texas prison system, consisting of the main penitentiary at Huntsville, Wynne Farm, about 4 miles north of the city, and Goree Farm, about 3.5 miles south.

The main generating units are one 5-cyl, 12.5 x 15-in , 400-rpm, 325-hp engine direct-connected to a 225-kw generator; one 8-cyl, 12.5 x 15-in., 400-rpm, 520-hp engine direct-connected to a 350-kw generator; and one 8-cyl, 14.5 x 18-in., 327-rpm, 685-hp engine driving a 480-kw generator. All engines are Superior units, convertible from gas to diesel operation with a few changes. The General Electric generators have direct-connected exciters.

Engine accessories include Alnor exhaust pyrometers, American Bosch magnetos, Ross oil coolers, Reliable tachometers, and Barbour-Stockwell overspeed control. A Curtis compressor, GE-motor driven, supplies starting air.

The cooling system consists of a Ross shell-and-tube heat exchanger in the power-plant building, with raw water taken from a large sump and cooling pond outside the building. The motor-driven Goulds circulating pumps stand near the heat exchanger, below the engine-room floor in a pit, with a gravity pressure head on the suction. A Scaife water-softening unit conditions makeup water for the closed system, maintaining the softness required for safe operation and scale-free cooling.

Pressure and temperature alarms warn of unusual conditions in the lube-oil system. Nugent filters in the pressure system protect against impurities and a Skinner unit provides complete reclaiming service.

Heat Recovery

Intake air goes directly to the engines through straight horizontal pipes running from the American air filters mounted on the plant wall. Engine exhaust lines extend below the floor, running horizontally to a bypass valve arranged to send the gas through Sims waste-heat boilers, or direct to the Maxim silencers outside the building. The waste-heat units supply hot-water for kitchen, laundry, and other purposes, supplementing boilers making steam for heating, cooking, and process work.

Power output of the engine-generators feeds through a Roller-Smith dead-front switchboard, with all switchgear enclosed in locked cabinets. The single compact unit comprises generator and feeder panels, General Electric instruments, voltage regulators, and automatic controls.

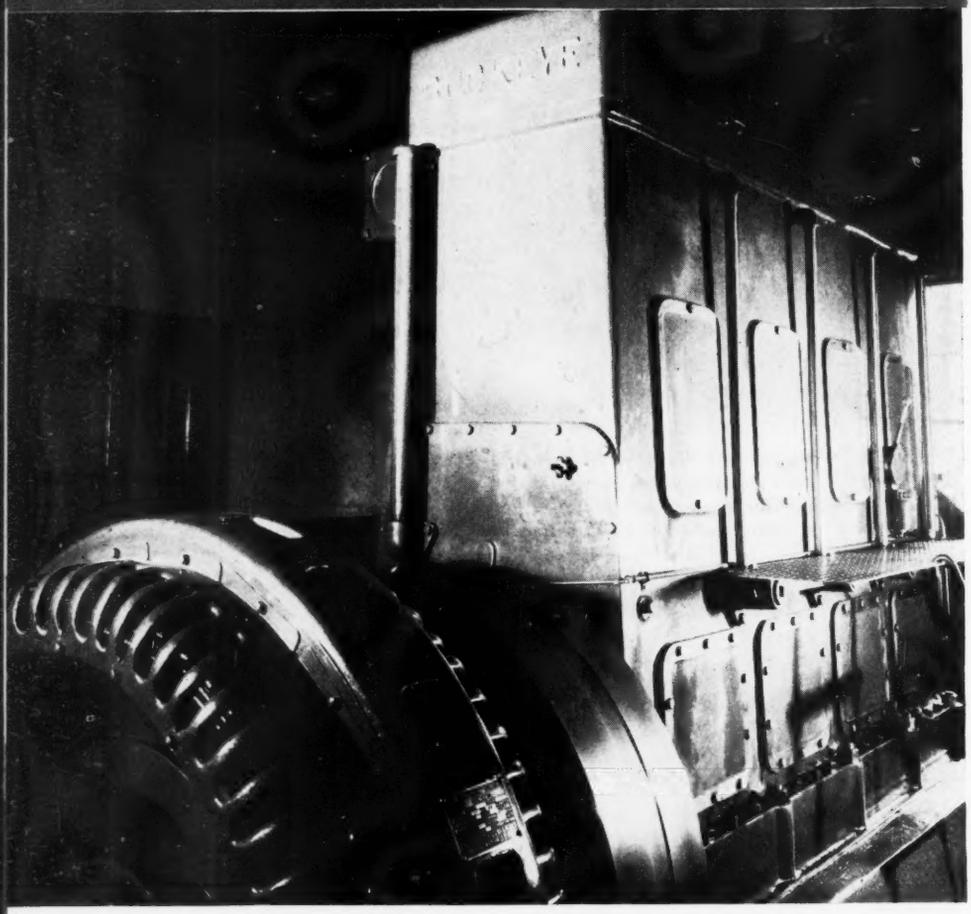
The plant operates 24 hours a day. The small engine can handle the average low day load, and the medium-size engine can take the usual peaks. The larger engine is sometimes needed for unusual peak loads, but since the maximum demand does not exceed 50% of total capacity, there is ample standby capacity. Engines are operated at most desirable capacity and are alternated in accordance with load variations. Woodward governors insure good frequency control and assist in load division.

Engineered by O J S Ellingson, General Manager of the Texas prison system, the plant, housed in an ample brick building, well lighted and ventilated, was designed and constructed entirely by inmates. Much of the material that went into the plant came from the prison's own brick plant, machine shop, foundry, and other industrial units. Operation of the plant by prison inmates has been entirely satisfactory.

For further data on convertible engines and "gas-diesels" see: "Municipal Chooses Convertible Engines," Sept, 1939; "Gas-Fired Diesel," Sept, 1937. For other articles on institutional plants, see: "Diesels Go to College," Dec, 1939; "Seasonal Diesel," March, 1939; "Steam in Winter, Diesel in Summer," Sept, 1938; "Diesels + Steam = Power," July, 1937.

FACTORY

Jacket heat from this 150-hp Buckeye diesel warms two 50x160 ft shops; exhaust heat supplies low-pressure steam needed for the plating process



▶ BECAUSE THE DIESEL'S high efficiency, even in small sizes, makes it ideal for power generation in metal-working shops and factories with no steam requirements except building heating, the extra economies that can be gained by utilizing waste-heat are often neglected. The new installation at the Littlestown Hardware & Foundry Co, Littlestown, Pa., shows how intelligent planning can make low-cost diesel power even cheaper and more effective.

Typical Plant

In this typical small metal-working plant, power loads don't exceed 100 kw and the only heat needs are building heating in winter and low-pressure steam for a plating process. With purchased power, two hand-fired boilers supplied these heating needs and it was necessary to keep the smaller of the two units running all summer to supply plating steam.

When considering a diesel to lower power costs, E H Snyder, president, and L D Snyder, treasurer, kept their thoughts focused on means of utilizing waste-heat without increasing first cost of the installation beyond a reasonable limit. With the cooperation of the diesel manufacturer, they worked out a system that will pay out in 4 to 5 years, according to estimates and operating experience since the end of 1939.

Power Unit

The new power unit is a 4-cyl, 9.5 x 14-in., 400-rpm, 150-hp Buckeye, fitted with Alnor selective pyrometer, Purolator on the lube-oil circuit, Briggs clarifier on the fuel circuit, and Grossco oil cooler. Lube oil continuously circulates through a Briggs clarifier unit for reconditioning. A Quincy compressor, driven by a GE motor, supplies starting air.

The engine drives a 156-kva, 0.8-pf, 125-kw, 240-volt, 60-cycle, 3-phase Elliott generator, with a V-belted GE exciter. R E S Swam, of Hanover, Pa., built the switchboard. A 10-hp tie with the utility system supplies small night loads for which it would be uneconomical to run the engine.

The engine jacket-cooling circuit is closed; soft makeup water comes from a tank kept filled by rain water caught in roof gutters. A motor-driven pump (Weinman) circulates jacket-water through a radiation system built up of 4 truck-radiator cores, welded together. This surface is mounted in a housing fitted with manually operated dampers and connected to a B F Sturtevant fan, powered by GE motor. The fan draws air, from the shop or from outside, over the finned coils and discharges into distributing ducts which carry the warmed air to the various parts of two 50 x 160-ft work rooms.

When less than full heat is required, the operator can adjust dampers to vent part of the warmed air to the atmosphere; in summer all heat goes out the roof vent. In case air cooling alone proves inadequate under summer conditions, water from a perforated pipe running at the top of the radiator coils will spray over the surface, providing the equivalent of an evaporative condenser. A Duro pump supplies soft water for this purpose, under control of a thermostatic switch set to cut-in the pump when jacket-temperature exceeds the desired limit for satisfactory engine operation.

Waste-Heat Recovery

To catch exhaust Btu's, the owners built a waste-heat boiler, designed on the vertical-fire-tube-boiler pattern, with gas flowing through about 90 1.5-in. tubes, 6 ft long. Water surrounds the tubes in the 24-in.-diameter shell, about 7 ft high. Steam from this unit flows to a series of perforated pipes in the plating tanks, to keep the solution at a boil. The only pressure on the open-end system is pipe friction, so pressure back at the boiler runs about 3–5 lb. This arrangement completely eliminates need for operating the small boiler in the summer months. After passing through the boiler, exhaust gas flows under the floor and outside to a stack. The waste-heat recovery system effectively muffles exhaust noise.

Adding the engine for private power generation involved no increase in personnel and the existing shop force will be able to take care of routine maintenance. Regular overhauls will be scheduled for slack periods.

Another small factory using diesels for low-cost power and heat was described in "Double-Acting Dollars When Diesels Do Heating," POWER, Nov. 1937.

TYPICAL DIESEL INSTALLATIONS

350 Installations In or Under Construction Since April 1, 1939

Owner	Location	Equipt Driven	Engine builder	No. units	Hp each	Rpm	No. Cyl	Cyl bore	Cyl stroke	Cycle	Starting Method	Fuel injection	Fuel, lb per hp hr	Other capacity, hp, in same plant if known
Iowa Public Service Co	Marshalltown, Iowa	C. S. Gen.	Nord	2	3600	225	9	21	29	2	A	A	....	.....
Lubbock	Texas	C. S. Gen.	Nord	1*	3200	225	8	21	29	2	A	A	....	.....
Bryan	Ohio	C. S. Gen.	Nord	1	3200	225	8	21	29	2	A	A	....	.....
Norwalk	Connecticut	C. S. Gen.	Nord	1	3000	225	7	21	31	2	A	S	....	.....
Sturgis	Michigan	C. S. Gen.	BuS	1	2475	240	8	20½	27½	2	A	S	0.395	1600-D
Miami	Oklahoma	C. S. Gen	Nord	1	2400	225	6	21	29	2	A	A	....	.....
Harlan	Iowa	C. S. Gen.	FIW	1	2000	225	8	23	28	4	A	S	0.38	2500-D
Federated Co-op Power Co	Reeve, Iowa	C. S. Gen.	Nord	1	2000	225	5	21	29	2	A	S	....	.....
Estherville	Iowa	C. S. Gen.	BuS	1	2000	240	6	20½	27½	2	A	S	0.39	.....
Federated Co-op Power Assn	Hampton, Iowa	C. S. Gen.	Nord	1	2000	225	5	21	29	2	A	S	0.39	5000-D
				1	1500	257	6	17	25	2	A	S	0.39	
Central Elect Federated Co-op Assn	Pocahontas, Iowa	C. S. Gen.	FIW	2	1500	225	6	23	28	4	A	S	0.39	2750-D
Lafayette	Louisiana	C. S. Gen.	FM	1	1400	300	8	16	20	2	A	S	....	4250-D
Union Potash Co	Carlsbad, N. Mex	Gen.	Nord	2	1250	257	5	17	25	2	A	A	....	.....
Shell Producers Co	Tampa, Fla	Pump	Sup	1	1200	327	8	14½	20	4	A	S	....	.....
		Gen.	Sup	1	900	327	6	14½	20	4	A	S	....	.....
Allison Engrg Co	Indianapolis, Ind.	Gen.	GM	2	1200	720	16	8½	10	2	E	S	....	.....
				2	450	720	6	8½	10	2	E	S	....	.....
Cushing	Oklahoma	C. S. Gen.	ALC	1	1170	257	8	17½	25	4	A	S	0.375	2250-D
San Antonio Portland Cement Co	San Antonio, Tex	Gen.	RJ	1	1150	233	6	19½	28	4	A	S	0.4	7500-D
Allegan	Michigan	C. S. Gen.	FM	1	1050	300	6	16	20	2	A	S	0.37	.....
Morgan City	Louisiana	C. S. Gen.	FM	1	1050	300	6	16	20	2	A	S	....	1260-D
Carmi	Illinois	C. S. Gen.	FM	1	1050	300	6	16	20	2	A	S	....	1160-D
New England Spun Silk Co	Boston, Mass.	Ind. Gen.	RJ	1	1025	277	8	16	24	4	A	S	0.39	.....
Ruston	Louisiana	C. S. Gen	BuS	1	1000	257	8	16½	24½	4	A	S	0.38	.....
Conway	Arkansas	C. S. Gen.	FIW	1	1000	225	8	17½	24½	4	A	S	0.375	1800-D
Key West Electric Co	Key West, Fla.	Gen.	BuS	1	1000	257	8	16¾	24½	4	A	A	0.42	.....
Warfield Co	Chicago, Ill	Gen.	Nord	1	1000	257	4	17	25	2	A	A	....	.....
Plattsburgh	New York	C. S. Gen.	FIW	3	1000	225	8	17½	24½	4	A	S	....	.....
Luverne	Minnesota	C. S. Gen.	FM	1	900	257	6	16	20	2	A	S	0.38	450-D, also S
Illinois Pipe Line	.....	Pump	RJ	2	890	277	7	16	24	4	A	S	0.4	.....
				2	750	277	6	16	24	4	A	S	0.4	.....
Blair	Nebraska	C. S. Gen.	BuS	1	875	257	7	16¾	24½	4	A	S	0.38	575-D, 400-S
Jackson	Minnesota	C. S. Gen.	FM	1	875	300	5	16	20	2	A	S	0.38	450-D, 600-S
Benton	Arkansas	C. S. Gen.	FM	1	810	277	5	16	20	2	A	S	....	1380-D
Canton	Missouri	C. S. Gen.	FM	1	805	300	7	14	17	2	A	S	....	875-D
N. Y. Telephone Co	New York, N. Y.	Standby Gen.	ALC	1	780	650	8	12½	13	4	A	S	0.39	.....
Osborne	Kansas	C. S. Gen.	BuS	1	750	257	6	16½	24½	4	A	S	0.39	.....
Franklin	Louisiana	C. S. Gen.	BuS	1	750	257	6	16½	24½	4	A	S	0.38	.....
Peoples Utilities, Inc	New Orleans, La.	C. S. Gen.	Sup	1	750	300	8	14½	20	4	A	S	....	.....
Lake Providence	Louisiana	C. S. Gen.	FM	1	750	257	5	16	20	2	A	S	....	960-D
Clinton	Michigan	C. S. Gen.	CB	2	730	257	7	15½	22	4	A	S	0.40	235-D
Charlevoix	Michigan	C. S. Gen.	RJ	1	725	257	6	16	24	4	A	S	0.4	650-D, 350-S
Greenfield	Iowa	C. S. Gen.	FIW	1	700	257	5	17½	24½	4	A	S	0.375	700-D
Melrose	Minnesota	C. S. Gen.	FM	1	690	300	6	14	17	2	A	S	0.38	600-D
F J J Sloat Dredging	Slidall, La.	Pump	FM	1	690	300	6	14	17	2	A	S	....	225-D
Lamar	Missouri	C. S. Gen.	FM	1	650	257	..	....	....	2	A	...	....	.....
				1	575	257	..	....	....	2	A	...	....	.....
				1	360	257	6	....	....	2	A	...	....	.....
Appleton Coated Paper Co	Appleton, Wis.	Gen.	BuS	1	625	257	5	16½	24½	4	A	S	0.38	750-S
Plainview	Nebraska	C. S. Gen.	Sup	1	625	400	8	12½	16½	4	A	S	....	.....
Rockport	Missouri	C. S. Gen.	BuS	1	625	257	5	16½	24½	4	A	S	0.38	.....
Corington	Tennessee	C. S. Gen.	FM	1	600	257	4	16	20	2	A	S	....	1180-D
Minden	Louisiana	C. S. Gen.	FM	1	600	257	4	16	20	2	A	S	....	1200-D
Siloam Springs	Arkansas	C. S. Gen.	ALC	1	540	600	6	12½	13	4	A	S	0.385	750-D
Magnolia Pipe Line Co	Indiana	Pumps	ALC	8	540	600	6	12½	13	4	A	S	0.39	.....
Osage City	Kansas	C. S. Gen.	BuS	1	500	327	6	13	20	4	A	S	0.40	.....
La Porte City	Iowa	C. S. Gen.	Wor	1	500	360	6	13¾	17½	4	A	S	0.40	525-D
Dime Bank Bldg	Detroit, Mich	Gen.	RJ	1	475	360	8	11	18	4	A	S	0.4	1340-S
Altamont	Illinois	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	0.36	450-D
Spring Valley	Minnesota	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	0.38	630-D
Preston	Minnesota	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	0.38	450-D
Fairfax	Minnesota	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	0.38	360-D
Augusta	Arkansas	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	....	360-D
General Minnesota Utilities	MacGregor, Minn.	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	0.38	360-D
Mt. Lake	Minnesota	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	0.38	450-D
Fairhope	Alabama	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	....	525-D
Madelia	Minnesota	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	0.38	.....
				1	300	300	4	14	17	2	A	S	0.38	.....
Bessemer	Michigan	C. S. Gen.	Wor	2	450	450	8	10¾	14½	4	A	S	0.41	.....
New Roads	Louisiana	C. S. Gen.	FM	1	450	300	6	14	17	2	A	S	....	540-D
Cumberland	Wisconsin	C. S. Gen.	Buc	2	450	360	6	13½	15½	4	A	S	0.4	.....
Weatherford	Texas	C. S. Gen.	FM	3	450	257	6	14	17	2	A	S	....	.....
Baird	Texas	C. S. Gen.	FM	2	450	257	6	14	17	2	A	S	....	.....
Brooklyn Brick Co	Brooklyn, Ind.	Gen.	Buc	1	400	514	8	10	12	4	A	S	0.4	.....
				1	75	600	3	7½	10½	4	A	S	0.4	.....
Grayling	Michigan	C. S. Gen.	Buc	2	375	360	5	13½	15½	4	A	S	0.4	.....
				1	225	400	6	9½	14	4	A	S	0.4	.....
Century Silica Co	Foxburg, Pa.	Gen.	Buc	1	375	360	5	13½	15½	4	A	S	0.4	.....
Electra	Texas	C. S. Gen.	Sup	1	350	400	5	12½	15	4	A	S	....	1050-D
Loffland Brothers	Orange, Texas	Drill	Sup	2	350	600	8	9	12	4	A	S	....	.....
Anita	Iowa	C. S. Gen.	Wor	1	330	360	4	13¼	17½	4	A	S	0.40	.....
				1	250	360	3	13¼	17½	4	A	S	0.40	.....
Fallbrook Public Utility District	Fallbrook, Calif.	Pump & Gen.	Ent	1	325	410	6	12	15	4	A	S	0.39	.....
Stowe-Davis Furniture Co	Grand Rapids, Mich.	Gen.	Sup	1	315	360	5	12½	15	4	A	S	....	.....
Gowrie	Iowa	C. S. Gen.	FM	1	300	300	4	14	17	2	A	S	0.38	450-D
Chetopa	Kansas	C. S. Gen.	ALC	2	300	300	4	...	...	4	A	..	....	.....
Cascade	Iowa	C. S. Gen.	FM	2	300	300	4	14	17	2	A	S	0.38	.....
Stilwell	Oklahoma	C. S. Gen.	DLV	2	300	300	..	...	....	..	A	...	....	.....
Rockford Stone Co	Rockford, Ohio	Gen.	Buc	1	300	450	7	10	12	4	A	S	0.4	.....
Lyons Construction Co	Whitehall, Mich.	Pump	Buc	1	300	400	8	9½	14	4	A	S	0.4	.....
U. S. Navy Dept	Bremerton, Wash.	Crane	Ent	1	300	600	6	9½	11½	4	A	S	0.39	.....
Piggott	Arkansas	C. S. Gen.	FM	1	300	300	4	14	17	2	A	S	....	360-D
Thomasville Ice & Mfg. Co	Thomasville, Ga.	Gen.	Sup	2	300	514	8	9	12	4	A	S	....	.....
Centerville	Mississippi	C. S. Gen.	FM	1	300	300	4	14	17	2	A	S	....	305-D
Humble Oil & Refining Co	Harvey, La.	Drill	Sup	2	300	500	8	9	12	4	A	S	....	.....
Halstad	Minnesota	C. S. Gen.	FM	1	300	300	4	14	17	2	A	S	0.38	.....
				1	120	360	2	12	15	2	A	S	0.38	.....
Prentiss	Mississippi	C. S. Gen.	FM	1	300	300	4	14	17	2	A	S	....	245-D
Bloomfield	Nebraska	C. S. Gen.	FM	1	300	300	4	....	....	2	A	...	....	200-D
Molokai Electric Co	Molokai, Hawaii	Gen.	Atlas	1	300	327	6	11½	15	4	A	S	0.41	1025-D
Coffenberry Lumber Co	Westpoint, Calif.	Sawmill	Atlas	1	275	514	8	9	10½	4	A	S	0.43	.....
Frank Marks & Sons	Newman, Calif.	Gen.	Atlas	1	275	514	8	9	10½	4	A	S	0.43	220-D

ABBREVIATIONS—ALC—American Locomotive Co, Atlas—Atlas-Imperial, Buc—Buckeye, Buda, BuS—Busch-Sulzer, Cat—Caterpillar, CB—Cooper-Bessemer, Clark—Clark Bros, DLV—De La Vergne, Ent—Enterprise, FIW—Fulton Iron Works, FM—Fairbanks Morse, GM—General Motors, KM—Krupp-Modaag, Nord—Nordberg, RJ—Rathbun-Jones, Sup—Superior (National Supply Co), Wor—Worthington.

Alt—Alternator, Com—Compressor, C S—Central Station, Gen—Generator, Ind—Industrial, Irrig—Irrigation, Mun—Municipal, Ref—Refrigeration.

Under other capacity, D is diesel, S is steam, G is gas. Under fuel injection, A is air, S is solid. Under starting method, A is air, E is electric, G is gasoline.

*Gas-diesel

Owner	Location	Equipt Driven	Engine builder	No. units	Hp each	Rpm	No. Cyl	Cyl bore	Cyl stroke	Cycle	Starting Method	Fuel injection	Fuel, lb per hp hr	Other capacity, hp, in same plant if known
Rowan Drilling Co	Houston, Texas	Gen.	Atlas	2	275	514	8	9	10½	4	A	S	0.43	.....
San Diego Marine Construction Co	San Diego, Calif.	Gen.	Atlas	2	275	514	8	9	10½	4	A	S	0.43	.....
				1	200	514	6	9	10½	4	A	S	0.43	.....
Gibson & Cushman	.....	Pump	Atlas	1	275	514	8	9	10½	4	A	S	0.43	.....
Fruen Milling Co	Minneapolis, Minn.	Gen.	Atlas	1	275	514	8	9	10½	4	A	S	0.43	450-D
Tioga Mills, Inc	Waverly, N. Y.	Gen.	Buc	2	262½	400	7	9½	14	4	A	S	0.4	.....
Eldred Drainage & Levee Dist	Carrollton, Ill.	Pump	Sup	2	260	600	6	9	12	4	A	S	....	.....
Magnolia Petroleum Co	Oklahoma City, Okla.	Drill	Sup	2	260	600	6	9	12	4	A	S	....	.....
Grant Contracting Co	Greenville, Ohio	Gen.	Sup	1	260	600	6	9	12	4	A	S	....	.....
Parker Drilling Co	Whiteface, Texas	Drill	Sup	1	260	600	6	9	12	4	A	S	....	.....
		Drill	Sup	1	175	600	4	9	12	4	A	S	....	.....
Maule Industries	Ojus, Fla.	Rock Crush	Sup	1	260	600	6	9	12	4	A	S	....	.....
Greenville Mfg. Co	Greenville, Ohio	Gen.	Sup	1	250	900	6	8	9½	4	A	S	....	.....
Parker Drilling Co	Olney, Ill.	Drill	Sup	2	250	800	6	8	9½	4	A	S	....	.....
Louisa, Des-Moines Co, D D No 4	Oakville, Iowa	Pumps	FM	1	240	400	6	10	12½	2	A	S	....	250-D
New York Telephone Co	Buffalo, N. Y.	Gen.	Sup	1	230	514	6	9	12	4	A	S	....	.....
R L Harrison Co, Inc	Saleno, N. Mex.	Comp.	Clark	1	225	300	3	13	14	2	A	S	0.42	.....
				1	150	300	2	13	14	2	A	S	0.42	.....
Patten Package Co	Calypso, N. C.	Shaft & Gen.	Buc	1	225	400	6	9½	14	4	A	S	0.4	.....
Beaver Dam Milling Co	Beaver Dam, Ky.	Shaft	Buc	1	225	400	6	9½	14	4	A	S	0.4	.....
Etowah Gin Co	Etowah, Ark.	Gin	Buc	1	225	400	6	9½	14	4	A	S	0.4	.....
Peerless Machinery Co	Joplin, Mo.	Gen.	Buc	1	225	400	6	9½	14	4	A	S	0.4	.....
Jonesville	Louisiana	C. S. Gen.	FM	1	225	300	3	14	17	2	A	S	....	180-D
Lowrance Bros	Driver, Ark.	Gin	Buc	1	225	400	6	9½	14	4	A	S	0.4	.....
Peoples Ice Co	Morgan City, La.	Gen.	FM	1	225	300	4	14	17	2	A	S	....	250-D
J L Parker, Jr	Panola, Ala.	Gin	FM	1	225	300	3	14	17	2	A	S	....	.....
Memphis	Missouri	C. S. Gen.	FM	1	225	300	3	14	17	2	A	S	....	550-D
Owensville	Missouri	C. S. Gen.	FM	3	225	300	3	14	17	2	A	S	....	.....
W A Thomasson	Eloy, Ariz.	Pump	Sup	1	225	600	6	8¾	9½	2	A	S	....	.....
Siems Drake Puget Sound Co	Kodiak, Alaska	Gen.	Atlas	1	210	360	6	10	13	4	A	S	0.41	.....
Newton Ice & Cold Storage	Newton, Ill.	Comp.	Atlas	1	200	514	6	9	10½	4	A	S	0.43	.....
Van Camp Sea Food Co	Terminal Island, Calif.	Gen.	Atlas	2	200	514	6	9	10½	4	A	S	0.43	.....
Wasteka Oil Co	Sacred Heart, Okla.	Gen.	Atlas	1	200	514	6	9	10½	4	A	S	0.43	825-D
Quartz Creek Dredging Co	Pierce, Idaho	Gen.	Atlas	1	200	514	6	9	10½	4	A	S	0.43	.....
Northwestern Herring Co	Drier Bay, Alaska	Gen.	Atlas	1	200	514	6	9	10½	4	A	S	0.43	.....
Charles Nunn Milling Co	Evansville, Ind.	Shaft & Gen.	Buc	1	200	514	4	10	12	4	A	S	0.4	.....
Oswego	Kansas	C. S. Gen.	FM	1	200	257	4	....	....	4	A	...	....	.....
				1	150	257	3	....	....	4	A	...	....	.....
O F Brough	West Millgrove, Ohio	Shaft	Buc	1	200	514	4	10	12	4	A	S	0.4	.....
A S Wallace	Roseburg, Ore.	Comp.	Atlas	1	200	514	6	9	10½	4	A	S	0.43	.....
Zuni Indian Agency	Black Rock, N. Mex.	Gen.	Sup	1	190	450	6	9	12	4	A	S	....	.....
Koehline Ice & Coal Co	Bridgeport, Ohio	Gen. & Comp.	Buc	2	187½	400	5	9½	14	4	A	S	0.4	.....
National Rice Mills, Inc	New Orleans, La.	Shaft	Buc	1	187½	400	5	9½	14	4	A	S	0.4	.....
Baltimore Cold Storage	Baltimore, Md.	Comp.	Buc	1	187½	400	5	9½	14	4	A	S	0.4	.....
Muskingum College	New Concord, Ohio	Gen.	Buc	1	187½	400	5	9½	14	4	A	S	0.4	.....
Parker Drilling Co	St. Johns, Kan.	Drill	Sup	2	175	600	4	9	12	4	A	S	....	.....
Poverty Hill Mine	Yuba City, Calif.	Pump	Sup	2	167	1200	8	5½	7	4	E	S	....	.....
Garkane Power Co	Hatch, Utah	C. S. Gen.	Sup	2	164	514	6	9	12	4	A	S	....	.....
Golden Gravels Mining Co	Junction City, Calif.	Gen.	Cat	1	160	850	8	5¾	8	4	G	S	0.43	.....
M J Ferrari	Placerville, Calif.	Saw	Cat	1	160	850	8	5¾	8	4	G	S	0.43	.....
Henderson County Drainage Dist	Carmen, Ill.	Pump	Cat	4	160	850	8	5¾	8	4	G	S	0.43	.....
Black Hawk Consolidated Mining Co	Silver City, N. M.	Comp.	Cat	1	160	850	8	5¾	8	4	G	S	0.43	.....
Ed Gentry	Marion, Ill.	MiningEquipt.	FM	1	150	300	2	14	17	2	A	S	....	.....
G A Wintzer & Son Co	Wapakoneta, Ohio	Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.4	.....
Littlestown Hdw & Fdry	Littlestown, Pa.	Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.4	.....
Rytex Co	Indianapolis, Ind.	Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.4	.....
Elliott Hardwood Co	Potsdam, N. Y.	Gen.	Buc	1	150	514	3	10	12	4	A	S	0.4	.....
Flat Rock Clay Products	Flat Rock, Mich.	Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.4	.....
Fred Akeberg	Los Angeles, Calif.	Irrig. Pump	Sup	1	150	....	4	8¾	9½	2	A	S	....	.....
Clarksville	Missouri	C. S. Gen.	FM	2	150	300	2	14	17	2	A	S	....	.....
Springfield Bronze & Aluminum Co	Springfield, Mass.	Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.4	.....
Panama Ice Co	New Orleans, La.	Comp. & Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.4	.....
Department of Interior	Crownpoint, N. Mex.	Gen.	Buc	1	150	400	4	9½	14	4	A	S	0.4	.....

Diesel Installations Under 90 Hp

Owner	Location	Equipt. driven	Engine builder	No. units	Hp each	Rpm	No. cyl	Bore	Stroke	Starting method
Delno Ice Co, Phoenix, Ariz		Comp	Atlas	1	140	360	4	10	13	A
Alaska Pacific Mining Co, Wasilla, Alaska		Gen	Atlas	1	135	514	4	9	10½	A
Smith Bros. Iron & Steel Co, Grand Rapids, Mich		Hyd Press	Sup	1	130	600	3	9	12	A
Louis Niebergall, Wheeling, W. Va		Comp	Sup	2	130	600	3	9	12	A
Peoples Ice Co, Pensacola, Fla		Gen	FM	1	130†	257	2	14	17	A
Heidelberg Hotel, Jackson, Miss		Comp	Cat	1	125**	850	6	5¾	8	G
G A Holland, West Salem, Ohio		Shaft	Buc	1	125	600	5	7½	10½	A
Asphalt Products Co, Dayton, Ohio		Gen	Cat	2	125	850	6	5¾	8	G
Bradley Mining Co, Clayton, Calif		Comp	Cat	2	125	850	6	5¾	8	G
R H Taylor, Trumann, Ark		Gin	Cat	1	125	850	6	5¾	8	G
M S Graybill & Son, Bareville, Pa		Gen	Buc	1	125	600	5	7½	10½	A
Wash Electric Co-op, E Montpelier, Vt.		CSGen	Cat	2	125	900	6	5¾	8	G
G L Nichols & Sons, N Montpelier, Vt.		Saw	Cat	1	125	850	6	5¾	8	G
Union Cold Storage Co., Chicago, Ill		Comp	Cat	1	125	850	6	5¾	8	G
Gold Producers, Inc, Shoup, Idaho		OreMill	Cat	2	125	850	6	5¾	8	G
Newburyport, Mass		Pump	Cat	1	125	850	6	5¾	8	G
Green Bay Drain Dist, Green Bay, Ia.		Pump	Cat	4	125	850	6	5¾	8	G
Film Center, New York, N. Y		Gen	Buda	1	115	720	6	6½	8¾	E
Zero Ice Co, Petersburg, Va		Comp	Buc	1	112½	400	3	9½	14	A
Eavey Co, Xenia, Ohio		Gen	Buc	1	112½	400	3	9½	14	A
San Leandro, Calif		Gen	Ent	1	110‡	600	4	8	10	A
Pennsylvania RR Co, Philadelphia, Pa.		Gen	Sup	2	110	1200	6	5½	7	E
Sabine Towing Co, Port Arthur, Tex		Pump	Atlas	1	105	650	6	6½	8½	A
W E Hoffman Ice Co, Harrisburg, Pa.		Comp	Atlas	1	105	360	3	10	13	A
Municipal Pump Station, Havre de Grace, Md		Pump	Buc	1	100	514	5	7⅛	10½	A
Arden-Rayshine Co, Watertown, Mass.		Gen	Buc	1	100	514	5	7⅛	10½	A
Corbin Brick Co, Corbin, Ky		Gen	Buc	1	100	600	4	7½	10½	A
R S Buchanan Co, Perry, Mo		Comp	Buc	1	100	514	5	7⅛	10½	A
Frank L Hazeltine, Merrimack, N. H.		.....	Cat	1	100	850	6	5¼	8	G
C E Bender, McConnelsburg, Pa		Comp	Cat	1	100	850	6	5¼	8	G
Yakima Ice Arena, Yakima, Wash		Comp	Cat	1	100	850	6	5¼	8	G
Jesse A Holmes & Son, Carver, Mass		.....	Cat	1	100	850	6	5¼	8	G
Western Boat Bldg Co, Tacoma, Wash.		Gen	Atlas	1	95	600	6	6½	8½	A
National Supply Co, California		Gen	Sup	1	95	1200	8	4½	5¾	E
U. S. Engineers, Rock Island, Ill		Gen	Sup	1	95	1000	6	5½	7	E
E Wood Sand & Gravel, Grayville, Ill.		Pump	FM	1	90†	450	3	8¾	10½	A
Kenwood Apartments, Great Neck, L. I.		Gen	KM	1	90†	600	3	6	10¾	A
Sheesleys Shows, Galveston, Tex		Gen	GM	5	90†	1200	6	4¼	5	E
Sols Liberty Shows, Caruthersville, Mo.		Gen	GM	1	90†	1200	6	4¼	5	E
Texas Longhorn Shows, Memphis, Tenn.		Gen	GM	2	90†	1200	6	4¼	5	E
Curly Vernon Shows, Memphis, Tenn.		Gen	GM	2	90†	1200	6	4¼	5	E
Buckeye State Shows, Laurel, Miss		Gen	GM	1	90†	1200	6	4¼	5	E
Yazoo Gravel Co, Yazoo City, Miss		Pump	GM	1	90†	1200	6	4¼	5	E
Shreveport Trade School, Shreveport, La		Gen	GM	1	90†	1200	6	4¼	5	E
Gold Medal Shows, Little Rock, Ark		Gen	GM	4	90†	1200	6	4¼	5	E
M H Pipkin, Sherrill, Ark		Gin	GM	1	90†	1200	6	4¼	5	E
E W K Andrau, Chocolate Bayou, Tex.		Pump	GM	1	90†	1200	6	4¼	5	E
Southern Sand & Gravel Co, Fluker, La.		Pump	GM	1	90†	1200	6	4¼	5	E
H J Longnbaugh, Katy, Tex		Pump	GM	1	90†	1200	6	4¼	5	E
Wolverton Bros, Lawton, Okla		Gen	GM	2	90†	1200	6	4¼	5	E
Dee Lang Shows, Memphis, Tenn		Gen	GM	5	90†	1200	6	4¼	5	E
Tornillo Gin Co, Tornillo, Tex		Gin	GM	1	90†	1200	6	4¼	5	E
Frank Burke Shows, El Paso, Tex		Gen	GM	2	90†	1200	6	4¼	5	E
Marion Harvey, Artesia, N. Mex		Pump	GM	1	90†	1200	6	4¼	5	E
Stahmann Farms, Las Cruces, N. M.		Gen	GM	1	90†	1200	6	4¼	5	E
Ryan Rd Snd & Grvl Co, Utica, Mich.		Pump	GM	1	90†	1200	6	4¼	5	E
Paris Woolen Mills, Stayton, Ore		Gen	GM	1	90†	1200	6	4¼	5	E
N Y Cold Storage Co, New York, N. Y.		Comp	GM	4	90†	1200	6	4¼	5	E
Fuller Brush Co, Hartford, Conn		Gen	GM	1	90†	1200	6	4¼	5	E
Merch & Farmers Gin Co, Altheimer, Ark		Gin	GM	1	90†	1200	6	4¼	5	E
Municipal Water Wks, Fosteria, Ohio.		Pump	GM	1	90†	1200	6	4¼	5	E
Stanley Fonds, Birmingham, Mich		Pump	GM	1	90†	1200	6	4¼	5	E
W H Champlin Co, Rochester, N. H.		Mill	GM	1	90†	1200	6	4¼	5	E
R W Briggs, Corpus Christi, Tex		Shaft	GM	1	90†	1200	6	4¼	5	E
State of Ohio, Waverly, Ohio		Pump	GM	1	90†	1200	6	4¼	5	E
Best Pencil Co, Irvington, N. J		Gen	GM	1	90†	1200	6	4¼	5	E
Industrial Trust Co, Providence, R. I.		Gen	GM	5	90†	1200	6	4¼	5	E
Crum Brainard Co, Whittier, Calif		Gen	GM	2	90†	1200	6	4¼	5	E
Diamond Braiding Mills, Chicago Hts, Ill		Gen	GM	1	90†	1200	6	4¼	5	E
				1	60†	1200	4	4¼	5	E
Evangeline Apts, New Orleans, La		Gen	GM	1	90†	1200	6	4¼	5	E
Penn Farm Bureau, Manheim, Pa		Gen	GM	2	90†	1200	6	4¼	5	E
Municipal Light Plant, Bellaire, Mich.		Gen	GM	2	90†	1200	6	4¼	5	E
Hennies Bros Shows, Shreveport, La		Gen	GM	9	90†	1200	6	4¼	5	E
Union Wire & Die Co, Stamford, Conn.		Gen	GM	1	90†	1200	6	4¼	5	E
				1	45†	1200	3	4¼	5	E
Uvalde Rock Asphalt Co, San Antonio, Tex		Shaft	GM	2	90†	1200	6	4¼	5	E
John R Ward Shows, Baton Rouge, La.		Gen	GM	1	90†	1200	6	4¼	5	E
				1	60†	1200	4	4¼	5	E
Durward Harper, Chocolate Bayou, Tex		Pump	GM	1	90†	1200	6	4¼	5	E
D C Parks, Bakersfield, Calif		Pump	Sup	2	90†	....	4	8¾	9½	A
P M Gregory, Palmdale, Calif		Pump	Sup	1	90†	....	4	8¾	9½	A
Albion Hotel, Miami Beach, Fla		Gen	GM	3	90†	1200	6	4¼	5	E

Owner	Location	Equipt. driven	Engine builder	No. units	Hp each	Rpm	No. cyl	Bore	Stroke	Starting method
Ira S Bushey, Brooklyn, N. Y.		Pump	Atlas	2	80	650	4	7	8½	A
H D Schell, Mifflintown, Pa.		Shaft	Cat	1	80	850	4	5¾	8	G
Ozark Pin & Bracket Co, Versailles, Mo.		.....	Cat	1	80	850	4	5¾	8	G
Ashley Ice Cream Co, Charleston S.C.		Comp	Cat	1	80	850	4	5¾	8	G
S A Luck & Son, Ashland, Va.		Saw	Cat	1	80	850	4	5¾	8	G
Orderville Pr & Lt Co, Orderville, Utah		Gen	Cat	1	80	850	4	5¾	8	G
W R Wade, Libby, Mont.		Mine	Cat	1	80	850	4	5¾	8	G
Bradford Dyeing Assn, Westerly, R. I.		Gen	Cat	1	80	850	4	5¾	8	G
Rusk Poultry Farm, Windsor, Mo.		Gen	Web	1	75†	550	3	7½	9	A
				1	50†	550	2	7½	9	A
Windsor, Missouri		Gen	Web	2	75†	550	3	7½	9	A
U. S. Dept Interior, Denver, Colo.		Gen	Sup	1	75	1300	6	4½	5¾	E
Earle Ice Plant, Bogalusa, La.		Comp	Buc	1	75	400	2	9½	14	A
Claassen Flour Mills, Newton, Kan.		Shaft	Buc	1	75	400	2	9½	14	A
New Mexico Mech Equip Co, N. Mex.		Comp	Sup	1	72	1200	6	4½	5¾	E
Phoenix Products Co, Milwaukee, Wis.		Gen	Black	2	70	420	1	11¾	15½	A
Heppner, Oregon		Pump	Cat	1	66	1400	6	4¼	5½	G
J R Williams, Jr, Monck's Corners, S.C.		Gin	Cat	1	66	850	4	5¼	8	G
Illinois Cooperage Mfg Co, Chicago, Ill.		Gen	Cat	2	66	1200	6	4¼	5½	G
				1	44	1200	4	4¼	5½	G
Forest E Wise & Sons, Greentown, Ohio		Shaft	Cat	1	66	850	4	5¼	8	G
Industrial Engineering Co, Los Angeles		Gen	Cat	2	66	1200	6	4¼	5½	G
Rip Van Winkle Mine, Elko, Nev.		Pump	Cat	1	66	850	4	5¼	8	G
Levin & Rosenberg, New York, N. Y.		Gen	Cat	1	66	1200	6	4¼	5½	G
San Leandro, California		Pump	Cat	1	66	1400	6	4¼	5½	G
Perry B Duryea, Montauk, L. I.		Comp	Atlas	1	65	450	3	8	10½	A
National Art Gallery, Washington, D.C.		Gen*	Sup	1	63	900	8	4½	5¾	E
Sohio Pipe Line Co, Brooklyn, Ind.		Gen	Sup	4	62	1200	6	4½	5¾	E
O V Clements, Bruce, Miss.		Saw	GM	1	60†	1200	4	4¼	5	E
Alfar Cream Co, W. Palm Beach, Fla.		Comp	GM	1	60†	1200	4	4¼	5	E
Wahl & Co, Hayti, Mo.		Comp	FM	1	60†	450	2	8¾	10½	A
Springfield, Missouri		Gen	Atlas	2	60	600	4	6½	8½	A
Murray Realty Co, Grd Rapids, Mich.		Gen	Buc	1	60	514	3	7⅞	10½	A
Continental Oil Co, Hobbs, N. Mex.		Pump	GM	1	60†	1200	4	4¼	5	E
				1	45†	1200	3	4¼	5	E
Breedings Drugs, Ft. Lauderdale, Fla.		Gen	GM	2	60†	1200	4	4¼	5	E
Bushwick Laundry, Brooklyn, N. Y.		Gen	GM	1	60†	1200	4	4¼	5	E
Nuco Paper Prod Co, Kansas City, Mo.		Shaft	Web	1	60†	300	1	15	15	A
Grand View Mine, Vanadium, N. M.		Comp	GM	1	60†	1200	4	4¼	5	E
Great Neck Ice Rink, Great Neck, L. I.		Comp	GM	1	60†	1200	4	4¼	5	E
				1	45†	1200	3	4¼	5	E
Wilmington Cold Str, Wilmington N. C.		Comp	GM	2	60†	1200	4	4¼	5	E
Seelig Furniture Co, New Orleans, La.		Shaft	GM	1	60†	1200	4	4¼	5	E
Mifflinville Flour Mill, Mifflinville, Pa.		Mill	GM	1	60†	1200	4	4¼	5	E
U. S. Coast Guard, Monterey, Calif.		Comp	Cat	2	60	850	3	5¾	8	G
Hall Planetary Co, Philadelphia, Pa.		Gen	GM	1	60†	1200	4	4¼	5	E
C E Coeting, Berlin, Mass.		Comp	Cat	1	60	850	3	5¾	8	G
Bronx Memorials Corp, Bronx, N.Y.		Comp	Cat	1	60	850	3	5¾	8	G
F L Rogers, Katy, Tex.		Pump	GM	1	60†	1200	4	4¼	5	E
De Quincy Ice Co, De Quincy, La.		Comp	FM	1	60†	300	1	12	15	A
Police Dept, New York, N. Y.		Gen	Buda	1	55	1200	6	4¼	5½	E
Livingston Shipbldg Corp, Orange, Tex.		Gen	Sup	2	50	1200	4	4½	5¾	E
Industrial Electric Co, Randle, Wash.		Gen	GM	1	45†	1200	3	4¼	5	E
Municipal Water Works, Howell, Mich.		Pump	GM	1	45†	1200	3	4¼	5	E
Donahues Restaurant, Newark, N. J.		Gen	GM	1	45†	1200	3	4¼	5	E
T Smith & Son, New Orleans, La.		Gen	GM	1	45†	1200	3	4¼	5	E
Sam Parish, Huntesville, Tex.		Gen	GM	1	45†	1200	3	4¼	5	E
South End Laundry, Huntesville, Tex.		Gen	GM	1	45†	1200	3	4¼	5	E
Kainer & Johnson, El Campo, Tex.		Pump	GM	1	45†	1200	3	4¼	5	E
Long Theatres, Bay City, Tex.		Gen	GM	2	45†	1200	3	4¼	5	E
H A Saathoff, Fairbanks, Tex.		Gen	GM	1	45†	1200	3	4¼	5	E
				1	15†	1200	1	4¼	5	E
Greenhorn Merc Co, Greenhorn, Colo.		Gen	GM	1	45†	1200	3	4¼	5	E
Carle Petroleum Co, San Antonio, Tex.		Gen	GM	1	45†	1200	3	4¼	5	E
J H Long, Carrizo Springs, Tex.		Pump	GM	1	45†	1200	3	4¼	5	E
Herweck & Oelkers, Carrizo Spgs, Tex.		Pump	GM	1	45†	1200	3	4¼	5	E
Rephans Dairy, Charleston, S. C.		Comp	GM	1	45†	1200	3	4¼	5	E
Homestead Mining, Pinos Altos, N. M.		Comp	GM	1	45†	1200	3	4¼	5	E
Nu-Sho Theatre, Broken Arrow, Okla.		Gen	GM	1	45†	1200	3	4¼	5	E
Jekyl Island Club, Brunswick, Ga.		Gen	GM	1	45†	1200	3	4¼	5	E
Hathaway Mach Co, Fairhaven, Mass.		Gen	GM	1	45†	1200	3	4¼	5	E
A J Shears & Son, Otsego, Mich.		Comp	GM	1	45†	1200	3	4¼	5	E
Shirlbee Dress Shop, Hackensack, N.J.		Gen	GM	1	45†	1200	3	4¼	5	E
Valley Oil Co, Merced, Calif.		Gen	GM	1	45†	1200	3	4¼	5	E
Nazareth Paper Box Co, Nazareth, Pa.		Gen	GM	1	45†	1200	3	4¼	5	E
Hotel Paso Del Norte, El Paso, Tex.		Gen	GM	1	45†	1200	3	4¼	5	E
Schofers Quality Bakery, Reading, Pa.		Gen	GM	2	45†	1200	3	4¼	5	E
City Consumers Ice Co, Jackson, Mich.		Comp	GM	1	45†	1200	3	4¼	5	E
Lake City Creamery, Lake City, Iowa.		Gen	Cat	1	44	1200	4	4¼	5½	G
Elmer B Thomas, Lancaster, Pa.		Gen	Cat	1	44	1200	4	4¼	5½	G
Alexander and Baldwin, California.		Gen	Sup	1	42	1200	4	4½	5¾	E
Walter H Horn, Shoemakerville, Calif.		Gen	Sup	1	33	1100	4	4½	5¾	E
Mt Pleasant Ice Cream Co, Thornwood, N. Y.		Comp	Black	1	37	500	1	8¾	13	A
Borough Island Heights, New Jersey		Pump	Atlas	1	35	650	2	6½	8½	A
Champion Speedways, Syracuse, N. Y.		Gen	Cat	1	32	1200	4	3¾	5	G
U S Gypsum Co, Jersey City, N. J.		Gen	Buda	1	25	1200	4	3⅜	5⅛	E
Mechanical Equipt Corp, Louisiana.		Gen	Sup	1	21	1200	2	4½	5¾	E
Wernimont Packing Co, Auburn, Iowa		Gen	Lis	1	21	1200	2	4½	5½	H
Ralph Lobdell, Waterloo, Iowa.		Comp	Lis	1	21	1200	2	4½	5½	H
Meade Hughes, Webster City, Iowa.		Comp	Lis	1	16	1200	2	4½	4⅞	H
Lake Tankers Corp, E. Chicago, Ind.		Gen	Lis	1	16	1200	2	4½	4⅞	H
J M Barth, Kennedy, Tex.		Gen	GM	1	15†	1200	1	4¼	5	E
Bassetts Restaurant, Angola, Ind.		Gen	GM	1	15†	1200	1	4¼	5	E
Harold Jones, Milford, N. J.		Shaft	GM	1	15†	1200	1	4¼	5	E
F L Edwards, W. Columbia, Tex.		Gen	GM	1	15†	1200	1	4¼	5	E
Grimes Veneer & Panel Co, Cleveland, Tex.		Blower	GM	1	15†	1200	1	4¼	5	E
Fairview Courts Cafe, Rosenberg, Tex.		Gen	GM	2	15†	1200	1	4¼	5	E
Owl Serv Sta Livingston Manor, N. Y.		Gen	GM	1	15†	1200	1	4¼	5	E
Lapham Brown Oil Co, Brookline, Mass.		Shaft	GM	2	15†	1200	1	4¼	5	E
Emgo Co, Ramapo, N. Y.		Gen	GM	2	15†	1200	1	4¼	5	E
Edgemere Dairy, Hialeah, Fla.		Comp	GM	1	15†	1200	1	4¼	5	E
Kimball's Laundry, Westboro, Mass.		Shaft	GM	1	15†	1200	1	4¼	5	E
Crown Pt Motor Pk, Thorofare, N. J.		Gen	GM	2	15†	1200	1	4¼	5	E
Carle Petroleum Co, San Antonio, Tex.		Gen	GM	1	15†	1200	1	4¼	5	E
Geo Belcher, Warton, Tex.		Gen	GM	1	15†	1200	1	4¼	5	E
Behr&Steinberger, Dillingham, Alaska		Gen	GM	1	15†	1200	1	4¼	5	E
Geo Beckerly, Pearl River, N. Y.		Gen	GM	1	15†	1200	1	4¼	5	E
F P Edwards, W. Columbia, Tex.		Gen	GM	1	15†	1200	1	4¼	5	E
Hartley Dairy Co, Portland, Ind.		Comp	GM	1	15†	1200	1	4¼	5	E
University of Tulsa, Tulsa, Okla.		Shaft	GM	1	15†	1200	1	4¼	5	E
E G Howard, Clay, Calif.		Pump	GM	1	15†	1200	1	4¼	5	E
Eagle Lake Theatres, EagleLake, Tex.		Gen	GM	1	15†	1200	1	4¼	5	E
Jungle Inn, Proctor, Ark.		Gen	GM	1	15†	1200	1	4¼	5	E

ABBREVIATIONS —— Atlas — Atlas-Imperial, Black — Blackstone, Buc — Buckeye, Buda — Buda, Cat — Caterpillar, FM — Fairbanks Morse, GM — General Motors, Lis — Lister, Sup — Superior (National Supply Co), Web — Weber.

Under starting method, A is air, E is electric, G is gasoline, H is hand.
* Standby. † 2-cycle engine, others are 4-cycle units.
** Nat. gas convertible unit. ‡ operates on sludge gas.

TYPICAL GAS-ENGINE INSTALLATIONS

150 Installations In or Under Construction Since April 1, 1939

Owner	Location	Equipt. Driven	Engine builder	No. units	Hp.	Speed, rpm	No. cyl	Cyl bore	Cyl stroke	Cycle	Btu per hphr	Type of fuel	Btu per cu ft fuel
Coastal Recycling Corp.	Banquette, Tex.	Comp	Clark	5	800	300	8	14	14	2	10,000	.....	....
				3	400	300	4	14	14	2	10,000	.....	....
El Paso Natural Gas Co.	Jal, N. Mex.	Comp	Clark	5	800	300	8	14	14	2	10,000	.....	....
Robstown	Texas	CS Gen	Sup	2	765	327	8	14½	20	4	10,000	Nat	1000
				2	570	327	6	14½	20	4	10,000	Nat	1000
Gulf Oil Co.	.....	Oil pump	RJ	3	650	327	5	15½	22	4	10,000	Nat	....
		Gen	RJ	2	600	300	5	15½	22	4	10,000	Nat	....
Continental Oil Co.	Villa Platte, La.	Comp	Clark	6	600	300	6	14	14	2	10,000	.....	....
				2	400	300	4	14	14	2	10,000	.....	....
				2	300	300	3	14	14	2	10,000	.....	....
L M Lockhart	Banquette, Tex.	Comp	Clark	2	600	300	6	14	14	2	10,000	.....	....
Harrison-Abercombrie	Old Ocean, Texas	Comp	CB	14	600	300	6	14	14	2	.....	Nat	....
Interstate Natural Gas Co.	Fowler, La.	Comp	Clark	1	600	300	6	14	14	2	10,000	.....	....
Corpus Christi Corp.	Driscoll, Tex.	Comp	Clark	1	600	300	6	14	14	2	10,000	.....	....
Colorado Interstate Gas Co.	Model, Colo.	Comp	Clark	1	600	300	6	14	14	2	10,000	.....	....
Canadian River Gas Co.	Dalhart, Tex.	Comp	Clark	4	600	300	6	14	14	2	10,000	.....	....
Memphis Natural Gas Co.	Lula, Miss.	Comp	Clark	1	600	300	6	14	14	2	10,000	.....	....
Panhandle East Pipeline	Tuscola, Ill.	Comp	Clark	2	600	300	6	14	14	2	10,000	.....	....
Prince George's Gas Co.	Washington, D. C.	Comp	Clark	1	600	300	6	14	14	2	10,000	.....	....
Shell Oil Co.	Seagraves, Tex.	Comp	Clark	7	600	300	6	14	14	2	10,000	.....	....
Standard Oil of Louisiana	N. Baton Rouge, La.	Comp	Clark	2	500	300	5	14	14	2	10,000	.....	....
Continental Oil Co.	Wichita Falls, Tex.	Comp	Clark	1	500	300	5	14	14	2	10,000	.....	....
Magnolia Cotton Mill Co.	Magnolia, Ark.	Gen	BM	1	450	240	4	18½	20	4	10,000	Nat	1000
Sulphur Springs Valley Electric Cooperative.	Wilcox, Ariz.	CS Gen	CB	5	420	450	8	11½	13½	4	.....	Nat	....
Phillips Pipe Line Co.	El Dorado, Kan.	Pump	Ster	1	400	900	8	8	9	4	10,000	Nat	1000
Roeser & Pendleton	Palestine, Tex.	Comp	Clark	1	400	300	4	14	14	2	10,000	.....	....
Phillips Petroleum Co.	Wichita, Kan.	Pump	Ster	1	400	900	8	8	9	4	10,000	Nat	1000
Phillips Pipe Line Co.	Syracuse, Mo.	Pump	Ster	1	400	900	8	8	9	4	10,000	Nat	1000
Atlantic Refining Co.	Philadelphia, Pa.	Comp	Clark	3	400	300	4	14	14	2	10,000	.....	....
Magnolia Petroleum Co.	Chaison, Tex.	Comp	Clark	4	400	300	4	14	14	2	10,000	.....	....
				2	200	300	2	14	14	2	10,000	.....	....
Phillips Pipe Line Co.	Buffalo, Okla.	Pump	Ster	1	400	900	8	8	9	4	10,000	Nat	1000
Phillips Pipe Line Co.	Cheney, Kan.	Pump	Ster	1	400	900	8	8	9	4	10,000	Nat	1000
Crow Drilling Co.	Great Bend, Kan.	Gen	Ster	1	400	900	8	8	9	4	10,000	Nat	1000
Phillips Pipe Line Co.	Gaylord, Tex.	Pump	Ster	1	400	900	8	8	9	4	10,000	Nat	1000
Cabot Carbon Co.	Wickett, Tex.	Comp	Clark	2	400	300	4	14	14	2	10,000	.....	...
				2	300	300	3	14	14	2	10,000	.....	....
Phillips Petroleum Co.	Kansas City, Kan.	Comp	Clark	2	400	300	4	14	14	2	10,000	.....	....
Phillips Pipe Line Co.	Cassoday, Kan.	Pump	Ster	1	400	900	8	8	9	4	10,000	But	....
Phillips Pipe Line Co.	Richmond, Kan.	Pump	Ster	3	400	900	8	8	9	4	10,000	Nat	1000
Phillips Pipe Line Co.	Madison, Kan.	Pump	Ster	3	400	900	8	8	9	4	10,000	Nat	1000
Union Gas Co.	Merlin, Canada	Comp	Clark	2	400	300	4	14	14	2	10,000	.....	....

Owner	Location	Equipt. Driven	Engine builder	No. units	Hp	Speed, rpm	No. cyl	Cyl bore	Cyl stroke	Cycle	Btu per hphr	Type of fuel	Btu per cu ft fuel
Continental Oil Co.	Iowa Park, Tex.	Comp	Clark	5	400	300	4	14	14	2	10,000	.....	....
Texas Pipeline Co.	South Bend, Tex.	Pump	Clark	1	400	300	4	14	14	2	10,000	.....	....
New Mexico Gas Co.	Aztec, N. Mex.	Comp	Clark	1	400	300	4	14	14	2	10,000	.....	....
Continental Oil Co.	Ponca City, Okla.	Comp	Clark	1	400	300	4	14	14	2	10,000	.....	....
Consolidated Gas Utilities	Shamrock, Tex.	Comp	Clark	3	400	300	4	14	14	2	10,000	.....	....
Dymo Oil Corp.	Litchfield, Ohio	Gen	IR	1	370	400	8	14⅛	13½	4	10,000	Nat	....
Standish Pipe Line Co.	Sharpe, Kan.	Pump	Ster	1	320	900	8	8	9	4	10,000	But	....
Indian Refining Co.	Lawrenceville, Ill.	Comp	Clark	1	300	300	3	14	14	2	10,000	.....	....
Socony-Vacuum Oil Co.	Brooklyn, N. Y.	Comp	Clark	1	300	300	3	14	14	2	10,000	.....	....
Glen Rose Gasoline Co.	Rodessa, La.	Comp	Clark	1	300	300	3	14	14	2	10,000	.....	....
Phillips Petroleum Co.	Nowata, Okla.	Gen	Ster	1	300	900	8	8	9	4	10,000	Nat	1000
Godfrey L Cabot Co.	Genesee, Pa.	Comp	Clark	1	300	300	3	14	14	2	10,000	.....	....
Imperial Oil, Ltd.	Calgary, Canada	Pump	NTP	1*	282	169	4	17	24	4	10,000	Ref	1400
				1*	131	157	2	17	24	4	10,000	Ref	1400
				1	80	575	6	6	9	4	10,000	Ref	1400
Phillips Petroleum Co.	Shidler, Okla.	Gen	LeRoi	4	250	900	12	6¾	7	4	10,000	Nat	1000
Barnsdall Pipe Line Co.	Refugio, Tex.	Pump	LeRoi	1	250	900	12	6¾	7	4	10,000	Nat	1000
Humble Oil & Refining Co.	West Texas	Pump	LeRoi	1	250	900	12	6¾	7	4	10,000	Nat	1000
Barnsdall Pipe Line Co.	Taft, Tex.	Pump	LeRoi	1	250	900	12	6¾	7	4	10,000	Nat	1000
Bountiful	Utah	CS Gen	LeRoi	1	250	900	12	6¾	7	4	10,000	Nat	1000
Hope Natural Gas Co.	Banen Creek, W. Va.	Comp	Clark	1	250	300	3	13	14	2	10,000	.....	....
Boston Consolidated Gas	Allston, Mass.	Comp	Clark	1	250	300	2	13	14	2	10,000	.....	....
Humble Oil & Refining Co.	Webster City, Tex.	Pump	LeRoi	1	250	900	12	6¾	7	4	10,000	Nat	1000
Greenville Sewage Disposal Plant	Greenville, S. C.	Gen	CB	2	225	450	4	11½	13½	4	11,000	Sew	650
New Riverside Ochre Co.	Cartersville, Ga.	Gen	BM	1	200	600	6	8¾	10½	4	10,000	Nat	1000
Columbian Fuel Corp.	Prestonsburg, Ky.	Comp	Clark	2	200	300	2	14	14	2	10,000	.....	....
Minard Run Oil Co.	Custer City, Pa.	Comp	Clark	1	200	300	2	14	14	2	10,000	.....	....
Newton	Kansas	Gen or Pump	Cli	1	200	900	8	6⅛	7	4	.....	.....	....
Atlantic Production Co.	San Diego, Tex.	Comp	Clark	1	200	300	2	14	14	2	10,000	.....	....
Belmont Quad Drill Co.	Bradford, Pa.	Comp	Clark	1	200	300	2	14	14	2	10,000	.....	....
Empire Fuel & Gas Co.	Alma, N. Y.	Comp	Clark	1	200	300	2	14	14	2	10,000	.....	....
				1	165	300	2	13	14	2	10,000	.....	....
Springfield	Missouri	Gen	Clark	2	198	514	6	9	11	4	.....	Sew	....
Federal Reserve Bank	Kansas City, Mo.	Gen	IR	3	185	400	4	14⅛	13½	4	10,000	Nat	....
W R Grimshaw Co.	Springfield, Mo.	Gen	Clark	2	180	514	6	9	11	4	10,000	.....	....
Anderson-Prichard Oil Corp.	Cyril, Okla.	Comp	LeRoi	1	165	900	8	6¾	7	4	10,000	Nat	1000
C L Denton	Denwood, Ark.	Gin	LeRoi	1	165	900	8	6¾	7	4	10,000	But	3200
Derby Oil Co.	Wichita, Kan.	Comp	Clark	1	165	300	2	13	14	2	10,000	.....	....
Edgeworth Water Co.	Edgeworth, Pa.	Gen	BM	1	165	277	4	12¼	15	4	.....	Nat	1020
E R Allen	Lubbock, Tex.	Gin	LeRoi	1	165	900	8	6¾	7	4	10,000	Nat	1000
National Biscuit Co.	Atlanta, Ga.	Pump	Ster	1	160	1750	6	5¼	6	4	10,000	Nat	1000
Middlebrook Gin	Athens, La.	Gin	BM	1	150	277	4	12¼	14	4	10,000	Nat	1000
Bethlehem Supply Co.	Tulsa, Okla.	Comp	Wau	1	140	850	6	7½	8½	4	.....	Nat	1050
Oklahoma Oxygen Co.	Tulsa, Okla.	Comp & Gen	BM	1	130	327	4	11	12	4	.....	Nat	1050
R E Brown & Son	Little Rock, Ark.	Gin	LeRoi	1	125	900	6	6¾	7	4	10,000	But	3200
Peoples Gin Co.	Bristol, Tex.	Gin	LeRoi	1	125	900	6	6¾	7	4	10,000	But	3200
Major Davis	Dawson, Tex.	Gin	LeRoi	1	125	900	6	6¾	7	4	10,000	Nat	1000
Yates & Crowley	Atlas, Tex.	Gin	LeRoi	1	125	900	6	6¾	7	4	10,000	But	3200
		Fan	LeRoi	1	25	1200	4	4	4	4	10,000	But	3200
P H Taylor	Sparkman, Ark.	Gin	LeRoi	1	125	900	6	6¾	7	4	10,000	But	3200
Wickham Packing Co.	Sapulpa, Okla.	Comp	CB	1*	125	275	2	12½	15	2	.....	Nat	1050
Rock Island	Illinois	Pump	Cli	5	125	1200	6	6	7	4	10,000	Sew	600
		Pump		2	75	720	6	6	7	4	10,000	Sew	600
		Gen		1	75	720	6	6	7	4	10,000	Sew	600
Lawler Hosiery Mills	Carrollton, Ga.	Gen	BM	1	100	600	3	8¾	10½	4	10,000	Nat	1000
Cedar Rapids	Iowa	Pump	Cli	1	100	720	8	6	7	4	10,000	Sew	600
Bloom Township Sanitary District	Chicago Heights, Ill.	Blower	Cli	1	100	720	8	6	7	4	10,000	Sew	600
Belleville	Illinois	Blower	Cli	1	100	720	8	6	7	4	10,000	Sew	600
Independent Ice & Service	Iowa Park, Tex.	Comp	BM	1	90	514	3	9	10½	4	10,000	Nat	1000
Western Refrigeration Co.	Chicago, Ill.	Comp	LeRoi	1	85	900	4	6¾	7	4	.....	City	800
Montgomery Bros.	Navarro, Tex.	Gin	LeRoi	1	85	900	4	6¾	7	4	10,000	But	3200
Sharon	Pennsylvania	CS Gen	NTP	2	80	600	6	6	9	4	10,000	Sew	900
Bulter	Pennsylvania	CS Gen	NTP	1	80	600	6	6	9	4	10,000	Sew	900
Individual Towel & Cabinet Service Co.	Chicago, Ill.	Gen	Buda	1	78	1200	6	4¾	6	4	.....	City	800
				1	41	1200	6	3 13/16	4¾	4	.....	City	800
Wausau	Wisconsin	Gen	Cli	1	75	720	6	6	7	4	10,000	Sew	600
		Gen	Cli	1	50	720	4	6	7	4	10,000	Sew	600
		Pump	Cli	1	50	720	4	6	7	4	10,000	Sew	600
Pueblo	Colorado	Pump	Cli	3	75	720	6	6	7	4	10,000	Sew	600
Aurora Sanitary District	Aurora, Ill.	Pump	Cli	2	75	720	6	6	7	4	10,000	Sew	600
Michigan City	Indiana	Blower	Cli	1	75	720	6	6	7	4	10,000	Sew	600
Manitowoc	Winsconsin	Pump	Cli	1	75	720	6	6	7	4	10,000	Sew	600
				1	35	720	4	5⅛	6¼	4	11,000	Sew	600
Davenport	Iowa	Gen & Pump	Cli	2	75	720	6	6	7	4	10,000	Sew	600
Kenosha	Wisconsin	Pump	Cli	2	75	720	6	6	7	4	10,000	Sew	600
Stevens Point	Wisconsin	Gen	Cli	1	75	720	6	6	7	4	10,000	Sew	600
Marion	Indiana	Blowers	Cli	2	75	720	6	6	7	4	10,000	Sew	600
		Pump	Cli	1	50	720	6	6	7	4	10,000	Sew	600
Wichita	Kansas	Pump	Cli	1	75	720	6	6	7	4	10,000	Sew	600
Pure Ice Co.	Fort Arthur, Tex.	Comp, Gen	BM	1	70	425	3	8¾	10½	4	10,000	Nat	1000
		Gen	BM	1	38	380	2	8½	9	4	10,000	Nat	1000
Kobe, Inc.	Oklahoma City, Okla.	Comp	Buda	1	60	850	4	6	7⅛	4	.....	Nat	1050
Peoples Nat Gas Co.	Wilkinsburg, Pa.	Gen	NTP	1	55	600	4	6	9	4	10,000	Nat	1000
Ward Ice Co.	Poleau, Okla.	Comp	NTP	1	55	600	4	6	9	4	10,000	Nat	1000
Ward Ice Co.	Rogers, Ark.	Comp	NTP	1	55	600	4	6	9	4	10,000	Nat	1000
Ithaca	New York	Pump	Cli	1	50	850	4	5¾	6½	4	10,500	Sew	600
Lake Charles	Louisiana	Blower	Cli	1	50	720	4	6	7	4	10,000	Sew	600
Carlsbad	New Mexico	Pump	Cli	2	50	850	4	5¾	6½	4	10,000	Sew	600
Twin Hills Country Club	Oklahoma City, Okla.	Pump	LeRoi	1	50	1150	4	5	6	4	10,000	Nat	1000
		Pump	LeRoi	1	40	1150	4	4½	6	4	10,000	Nat	1000
Barnsdall Oil Co.	West Texas	Pump	LeRoi	1	50	1200	4	5	6	4	10,000	Nat	1000
Wolfinger Grist Mill	Boynton, Okla.	Mill	Cat	1	50	600	4	4¾	6½	4	.....	Nat	1050
Metairie	Louisiana	Blower	Cli	1	50	720	4	6	7	4	10,000	Sew	600
Phillips Petroleum Co.	Oklahoma City, Okla.	Pump	Buda	1	45	850	4	5¾	7⅛	4	.....	Nat	1050
Shutton Grain Co.	Checotah, Okla.	Corn sheller	MM	2	45	1000	4	5½	6¾	4	.....	Nat	1050
		Grain elevator											
Quart Grist Mill	Chandler, Okla.	Mill	AC	1	45	1000	..	....	....	4	.....	Nat	1050
Two Rivers	Wisconsin	Blower	Cli	1	43	720	4	5¾	6½	4	10,000	Sew	600
		Pump	LeRoi	1	40	900	4	5	6	4	10,000	Sew	600
Escanaba	Michigan	Gen	LeRoi	1	40	900	4	5	7	4	10,000	Sew	650
Iowa Great Lakes Sewage Diversion System.	Okoboji, Ia.	Blower	Cli	2	40	900	4	5⅛	6¼	4	11,000	.....	....
Grenleaf Dairy Co.	Muskogee, Okla.	Comp	Int	1	40	1000	4	4¾	6	4	.....	Nat	1050
Shawano	Wisconsin	Gen	LeRoi	1	35	745	4	5	6	4	10,000	Sew	600
Crawfordsville	Indiana	Blower	LeRoi	1	35	600	4	5	7	4	10,000	Sew	600
Ecker-Erhardt Co.	Chicago, Ill.	Comp	Buda	1	35	1200	6	4	4½	4	.....	City	800
Muskogee Mill & Elevator Co.	Muskogee, Okla.	Elevator	Int	1	35	1400	6	3¾	4½	4	.....	Nat	1050
Wood Oil Co.	St. Louis, Okla.	Pumping rig	Clark	1	30	600	2	5¾	7	2	15,000	.....	....
Litchfield	Illinois	Gen	Cli	1	30	720	4	5⅛	6¼	4	11,000	Sew	600
Arctic Ice Cream Co.	Chicago, Ill.	Comp	Wau	1	30	1300	6	3¾	4¼	4	.....	City	800
Balfour-Guthrie & Co.	New York, N. Y.	Pumping rig	Clark	6	30	600	2	5¾	7	2	15,000	.....	....
Redmer Sons Co.	Chicago, Ill.	Gen & Shaft	Auto	1	28.8	1650	8	3 3/16	3¾	4	.....	City	800
Edgewater Laundry	Chicago, Ill.	Gen	Int	1	28.3	1730	6	3 7/16	4	4	.....	City	800
Johnson & Dillon	Chicago, Ill.	Comp	Wau	1	28	1200	6	3¾	4¼	4	.....	City	800
Garment Cleansers	Chicago, Ill.	Shaft	Hercules	1	27	1300	4	4	4½	4	.....	City	800
			Cont	1	26.3	1300	6	3¼	4⅜	4	.....	City	800
Thor Press	Chicago, Ill.	Gen	Auto	1	27	1400	6	3⅜	3⅞	4	.....	City	800
Monroe	Michigan	Pump	Cli	1	25	600	4	4⅜	5¼	4	11,000	Sew	600

ABBREVIATIONS—AC—Allis-Chalmers; Auto—Various automotive engines converted to gas; BM—Bruce-MacBeth; Buda—Buda; Cat—Caterpillar; CB—Cooper-Bessemer; Clark—Clark Bros; Cli—Climax; Con—Continental; Her—Hercules; Int—International Harvester; IR—Ingersoll-Rand; LeRoi—LeRoi; MM—Minneapolis-Moline; Nord—Nordberg; NTP—National Transit Pump; RJ—Rathbun-Jones; Ster—Sterling; Sup—Superior (National Supply Co); Wau—Waukesha.

Under type of fuel: But—butane, City—city gas, Nat—natural gas, Sew—sewage gas.

* Horizontal units; all others are vertical. Also, all installations are single-engine units with the exception of these two, first of which is a twin tandem, the other a twin unit.

Established 1882 POWER PHILIP W SWAIN, Editor

A Word for Research

I want to say a good word for scientific research, but not because it needs any help from me.

The point is this: I have written some strongly worded editorials on the practical side. Reading these, some of my friends have concluded that I am an advocate of the sledge-hammer school of engineering and "agin" the slide-rule variety. This is not the fact. What I really favor is any variety of engineering that will best do the given job. Let me illustrate:

If I were looking for a good operating man I wouldn't give much weight to a knowledge of calculus, because there is little chance to apply such knowledge in running a plant. I would look for experience, horse sense, mechanical skill, ability to get along with men and a practical understanding of machines, because these have proved to be the essentials of operating skill.

Not for a minute would I apply the same specification to a research man. If I wanted someone to explore the unknown land beyond the present borders of engineering practice, I would look first for a man with the scientific spirit—one with an analytical mind and unlimited curiosity. Next I would make sure that he was well grounded in physics, chemistry, thermodynamics, mathematics, metallurgy and so on. I would do so because experience shows that the most important findings are made by the research laboratories with the best theoretical underpinning.

Our debt to scientific pioneers is beyond calculation. Their research has given us the X-ray, radium, all modern forms of electric light, photography, optical glass, all the new plastics, rayon, many new paints and varnishes, the high-speed airplane, an enormous increase in agricultural productivity, the cure for many pests and blights, and so on without limit.

It has saved our lives countless times with such medical discoveries as the germ theory of disease, sterile technique, anesthetics, the prevention or cure of most plagues and other germ diseases, the fever machine and such wonderworking preparations as insulin, thyroxin, adrenaline, digitalis, and sulphanilimide.

We mechanical and electrical engineers must credit research with the steam tables, high-speed steel, the fundamental principles of mechanics and of all electrical machinery, the chemistry of water treatment, thousands of new alloys.

Some of these achievements came from a direct search for the solution of practical problems. Many others were the unexpected byproducts of "pure" research—the sort in which the researcher merely follows his scientific curiosity, letting the chips fall where they may.

Because they know it pays, America's largest and most successful firms spend many millions annually on scientific research, much of it on problems that seem far afield.

The yearly research budget of duPont is around $5,000,000. Aluminum Company of America, Eastman Kodak, General Motors, General Electric, International Nickel and Westinghouse have invested over $8,000,000 in research buildings and equipment. In all they employ more than 750 research scientists, assisted by 1200 clerical workers and mechanics. The big oil companies spend other millions.

Each of these companies has found its research dollar the best investment, yet research benefits the public even more than the stockholders, because it raises the living standard of the entire nation.

You might say that mankind has two jobs. One is to keep the world alive from day to day—to keep factories and trains running, houses warm, people clothed and fed. Most engineering work falls in this category.

But there's another job to be done, the job of pioneering into the unknown to make tomorrow's world better than today's. That's research and I'm for it. Every intelligent engineer is for it, whether or not he can personally participate.—*PWS*

Suspension of High-Temperature Piping

Weight of a piping system becomes redistributed when temperature is raised to 750-950-F range. Constant-support hangers keep weight stresses out of pipe material, according to J Kaye Wood,* chief engineer of General Spring Corp

▶ THE CHANGE of axial configuration of a pipeline due to thermal expansion under the external restraining action of fixed ends and guides creates a complicated stress condition in the pipe wall which has been the subject of considerable study in recent years. There have existed for some time well established methods for determining maximum stress due to change of axial configuration which can be classified as straight-analytic, grapho-analytic and scale-model-analytic. In all of these methods the effect of weight and hanger characteristics are ignored.

This article considers only those stresses induced in the pipe by that part of the pipe weight not borne by the hanger supports and develops the relationship of hanger and pipe characteristics to this unborne weight in order that an adequate design procedure can be established. These stresses will be called *weight-transfer stresses* in order to distinguish them from others due to external restraints, here called expansion stresses.

Four Stresses

The four different high-temperature-pipeline stresses may be classified as follows: (a) expansion stresses, (b) weight-transfer stresses, (c) internal-pressure stresses, (d) cold-sagging stresses. The stresses are determined independently and combined properly to obtain maximum resultant stress.

The first step in the design of any pipeline suspension irrespective of its temperature is to determine number, supporting capacities and locations of hangers required to meet the following conditions:

(1) *The sum of the weights of elementary pipeline sections and supporting forces exerted by hangers and end reactions shall be equal to zero.*

(2) *The sum of the moments of elementary weights acting at their centers of gravity and the supporting forces about both the* x *and* y *axes shall be equal to zero.*

(3) *The spans between hanger and hanger or hanger and end reaction shall be limited to prevent excessive sagging stresses.*

Under these conditions, while the pipe is "cold" (62.5 F), the resultant maximum stress is the sum of the cold-sagging stress plus the longitudinal component of the internal-pressure stress. No expansive or weight-transfer stresses exist except where "cold springing" is employed.

Suppose that the temperature of the pipe is elevated causing a change in its axial configuration. At each point where a hanger is attached, the shift is resolved into its components along the three principal axes. The directions and magnitudes of these components are usually shown on piping drawings. The vertical component or shift ε is of chief concern because of the consequent gravitational influence on the supporting system. Some type of flexible hanger naturally suggested itself when first appreciable vertical shifts began to be experienced. Helical-compression and elliptical springs came into use as pipe hangers but due to the change of supporting effort exerted by hangers of this type under the influence of the vertical shift, the constant-support type of hanger (Fig. 1) came into use later. Horizontal shifts are easily provided for by roller seats when ε equals zero and by pivot-connected or roller-supported hangers when ε is greater than zero.

The magnitude of the vertical shift depends upon the total temperature and the effective length of the vertical section of the pipeline. There was a time when 750 F was the temperature "ceiling", until three or four years ago it was 850 F, and today it is 950 F, with indication that we are approaching an asymptotic value of 1000 F. It is usually assumed that the pipe material is at the same temperature as the fluid carried.

Linear thermal expansion of pipe materials, such as carbon or carbon-molybdenum steels, can be expressed, for convenience, as the increase of a 100-ft length of pipe, measured along its axis, for a given temperature range starting at 62.5 F and ending at the total temperature. Thus, for a total temperature of 750 F, the increase of length is 6½ in., for 850 F, it is 7½ in., and for 950 F, it is 8¾ in.

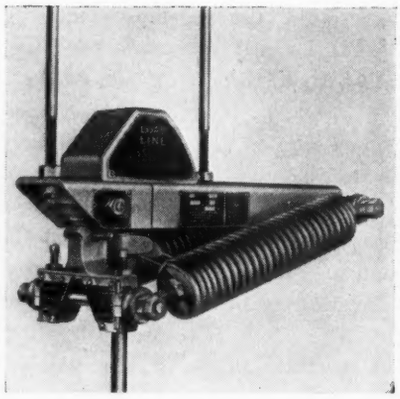


Fig. 1—"Genspring" hanger; when pipe expands, supporting capacity is constant

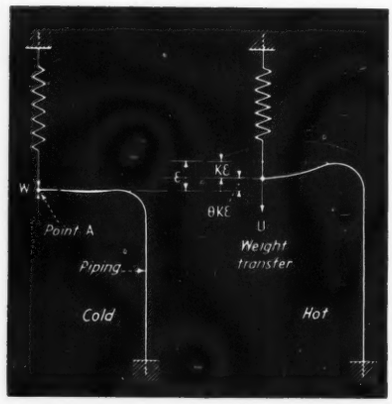


Fig. 2—Simple hanger; when pipe expands supporting capacity is variable

To determine the effect of vertical shift on the supporting system, consider the spring in Fig. 2 which supports the piping at point *A*, the capacity of the spring being made equal to the weight reaction *W* at this point when the pipe is "cold." When the pipe is "hot", and expansion occurs, the initial deflection of the spring is reduced by an amount somewhat less than the vertical shift ε. This is due to the combined effects of the stiffness factors of the spring and pipe, that is, when the point *A* is raised, the sup-

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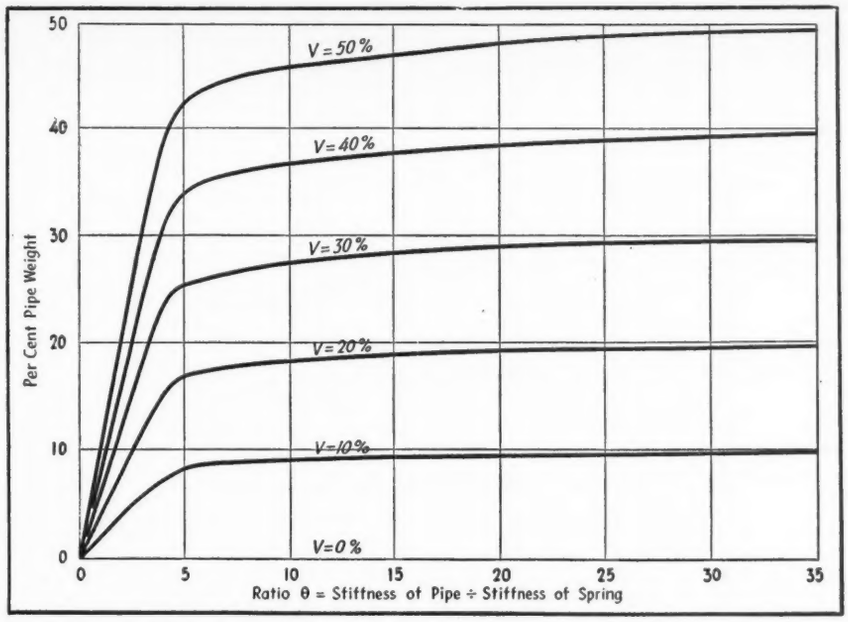


Fig. 3—For most applications, the percent of pipe weight transferred to the pipe per in. of vertical shift is practically equal to the variability factor, V, which is percent change in hanger supporting capacity per in. of deflection

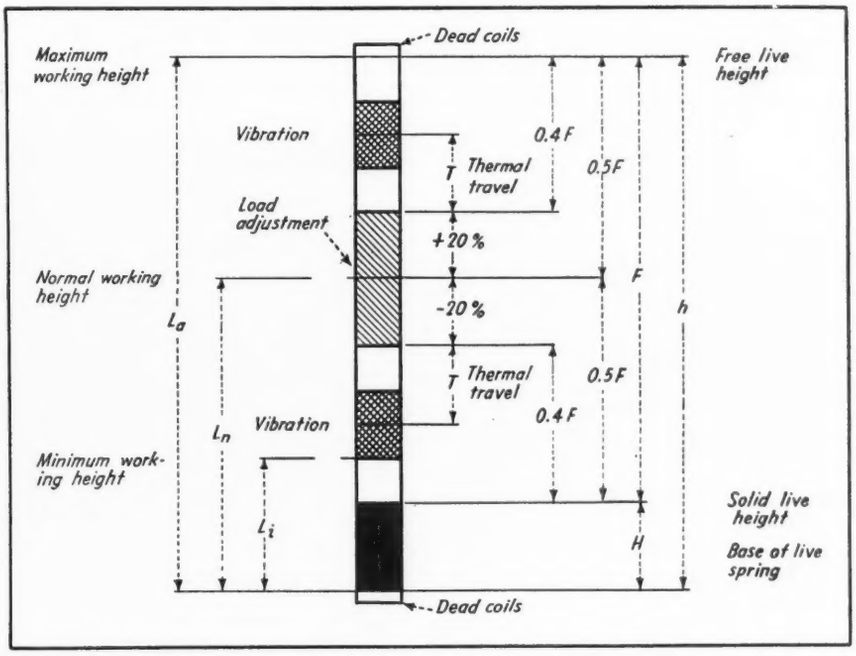


Fig. 4—Representation of the working range of a helical spring incorporated in a variable-support spring hanger. H is shown relatively smaller than actual

porting capacity of the spring is reduced and the difference between this new capacity and the weight reaction (which does not change with expansion) deflects the pipe downward. Equilibrium between the spring and pipe is reached with a resultant decrease in the initial deflection of the spring equal to some fractional part of the vertical shift. The decrease U in the initial supporting capacity of the spring is transferred to the pipe at point A and thereby induces a bending stress in it.

The portion of the weight transferred from the hanger to the pipe at point A is given by the following expression:

$$U = \epsilon\, k_p \frac{k_s}{k_s + k_p} = \epsilon\, k_p\, K \qquad (1)$$

in which k_p is the stiffness of the pipe and k_s the stiffness of the spring in lb per in. of deflection. K has been labeled by the writer in a previous article** as the "hanger protection factor."

If we let $\theta = k_p/k_s$ and $V = 100\, k_s/W$ we obtain,

$$100\,\frac{U}{W} = V\left(\frac{\theta}{1+\theta}\right) \qquad (2)$$

in which V equals the reciprocal of the initial deflection produced by its corresponding load, W, multiplied by 100. This term the writer has labeled the *percent variability* of the hanger. It *gives the percent decrease or increase of supporting capacity in lb per in. of deflection.*

We therefore may state that the percent of pipe weight transferred from the hanger to the pipe per in. of vertical shift is equal to the percent variability of the hanger multiplied by the factor $\frac{\theta}{1+\theta}$ (pure number). It is obvious from this that the greatest pipe protection is obtained when V equals or approaches zero, or, referring to equation (1), when k_s equals or approaches zero. When V, and consequently k_s, equal zero, we have a flexible hanger of the constant-support type (Fig. 2) or a counterweight system. In simple spring hangers V or k_s never equals zero and can be made small only by increasing the length of the spring, a value of 20% being obtained for an over-all hanger length of 30 to 40 in. depending on the details of construction. To obtain the fullest pipe protection, a constant-support hanger must be used.

Percent Variability

Fig. 3 shows a family of variability curves which give percent of pipe weight transferred to the pipe per in. of vertical shift for values of the ratio θ, (k_p/k_s). Usually, the stiffness of the pipe, k_p, is large with respect to stiffness of the spring, k_s, which means that the horizontal or flat portions of the curves apply. In turn the percent of pipe weight transferred to the pipe per in. of vertical shift is practically equal, numerically, to the percent variability, V. It is not safe, however, to assume this true in all cases, particularly for long horizontal stretches of pipe with unrestrained ends or for small pipe diameters.

To determine the transferred weight, U, for a given hanger, it is necessary to know the vertical shift, ϵ, and the stiffness factors, k_s of the spring and k_p of the pipe, at the point of hanger attachment (point A in Fig. 2).

The determination of the vertical shift, ϵ, has already been explained. It should be noted that under the combined action of spring and pipe the point A actually moves a distance of $\theta\, K\, \epsilon$ while the deflection of the pipe at point A equals $K\, \epsilon$. In practice, hangers of either the variable- or constant-support types are usually provided with

** "The Balanced Support of High-Temperature Pipe Lines," J Kaye Wood, *Engineering*, Dec 3rd and 10th, 1937.

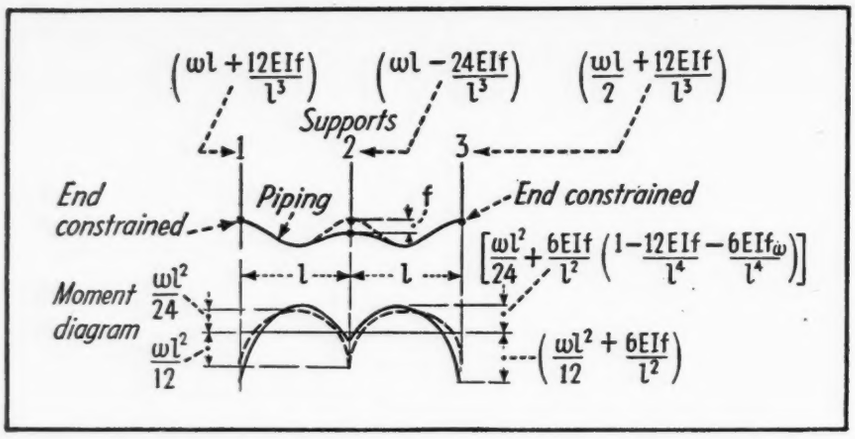


Fig. 5—Typical moment diagram for adjacent pipe-hanger supports

total vertical travels of ε plus a factor of safety.

The determination of the stiffness rate, k_s, is a matter well within the control of the designer. However, with a view to improving this phase of hanger calculations, the writer offers the following new method which greatly simplifies and shortens the work.

Stiffness Rate

To select the most advantageous value of the percent variability, V, it is convenient to relate the various factors in spring design to the two quantities k_s and V. Referring to the spring-service diagram, Fig. 4, which represents a helical-compression spring in a variable-support spring hanger, F is the maximum possible deflection in inches and $F/2$ is the normal working deflection corresponding to the weight, W, to be supported by the hanger. Consequently, $F/2$ multiplied by 100 is the percent variability, V, of the hanger. An adjustment range of ±20% is allowed for the normal working load. The actual thermal travel, T, in inches, (equal to $\varepsilon K \theta$) is provided for at each end of the load adjustment range in case the travel is up or down and to take care of "cold-springing" if required. Superimposed on the ends of the thermal-travel ranges are the vibrational amplitudes if any exist. The minimum and maximum working heights are determined by the outer ends of the vibrational ranges.

For safety in spring design the *spring criterion* must be equal to or less than the *material index*†, that is,

$$\frac{h-H}{H} \times \frac{1}{C_2} \leqq \frac{4}{5}\,\frac{\pi}{}\,\frac{S}{G} \qquad (3)$$

in which C is the *spring index* equal to D/d, D being the mean diameter of the spring and d the bar diameter, both in inches. S is the safe maximum stress for the solid deflection F, and G is the torsional modulus, usually taken as 11,500,000 psi. For pipe hangers a spring index of 6 is most satisfactory, greater than this tends towards buckling and a lesser value produces severe curvature effects.

Considering the possibility of a vibration range at the lower end of the total deflection the value of the safe maximum stress, S, should be taken as 82,000 psi, which, from the meager fatigue data available, appears to be a safe value for the endurance limit based upon a spring index of 6 and a curvature correction factor of 4/5.

Under these assumptions, the safe maximum solid deflection, F, as calculated from equation (3), is equal to 65% of the live solid height, H, and the normal working deflection ($F/2 = 100/V$) is equal to 32½% of the live solid height.

The normal working load, W, corresponding to $F/2$, is equal to $2163\ d^3$. Since the required value of W may not yield a value of d equal to a commercial bar size, the value of D should be taken as $6d\sqrt[3]{W_1/W}$ in which W_1 is the load corresponding to the nearest gage size of the bar and W is the required load. This adjustment affects only the safe maximum solid deflection but not sufficiently to alter appreciably the factor of safety.

The essential requirement, the value of V, is related to other factors of the live spring as follows:

$$V = \frac{508}{h} = \frac{100\ k_s}{W} = \frac{408}{L_s} = \frac{308}{N\ d} \qquad (4)$$

in which N is the number of live coils.

We also have,

$$L_s = \frac{428}{V} + T + \text{vibration amplitude} \qquad (5)$$

$$L_i = \frac{388}{V} - T - \text{vibration amplitude} \qquad (6)$$

The maximum working stress corresponding to the minimum working height L_1 is:

$$S_i = 49{,}176 + 410\,V\,(T + \text{vibration amplitude}) \qquad (7)$$

The natural frequency in number of vibrations per minute is given by:

$$\text{Natural frequency} = 18.76\sqrt{V} \qquad (8)$$

We also have the important practical relationship:

$$\text{Over-all hanger height} = L_s + 1.5d + 12 \text{ in.}$$

$$= \frac{428}{V} + 15 \text{ in.} + T + \text{vibration amplitude} \qquad (9)$$

in which d is assumed to have a maximum value of 2 inches.

In equation (8) it will be noted that the natural frequency of vibration is directly proportional to the square root of the percent variability. This means that simple or variable-support spring hangers have a definite natural frequency of vibration which, if equal or close in value to the frequency of a vibration impressed upon the piping system, is likely to produce a state of resonance.

Any augmenting of the vertical shift by resonance greatly increases weight transfer and consequently stress in the pipe. This is not true of constant-support hangers because (since the percent variability is equal to zero) they do not have a natural frequency of vibration. If hangers of this type have an appreciable degree of frictional or other hysteresis, they will effectively dampen vibration in a vertical plane.

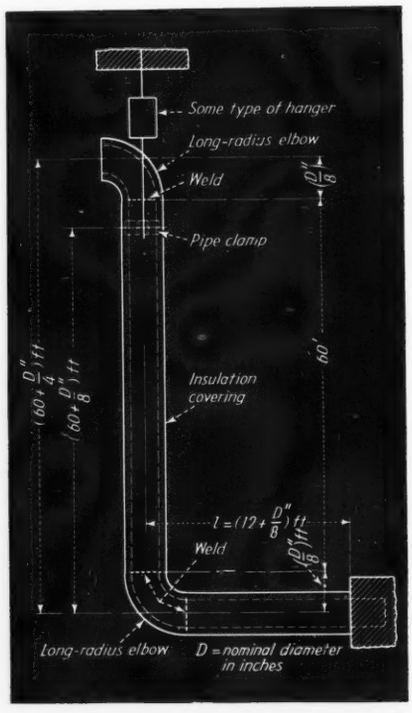


Fig. 6—Piping layout for stress calculations shown in Fig. 7

† See *American Machinist*, vol. 54, page 628: "The Design of Helical Springs," by J Kaye Wood.

The determination of the stiffness of the pipe, k_p, is not always an easy matter. This value can usually be determined by applying the theory of three moments to the points of attachment of three adjacent hangers. Thus in Fig. 5, in which sag between hanger supports is greatly exaggerated and ends are fully constrained, the relative elevation of the center support is decreased by f inches resulting in a decrease of the weight reaction at this point of P pounds.

Before depressing the middle support, the weight reactions for the three supports are each equal to $wl/2$ where w is the weight of pipe per linear ft. After depressing the middle support f in., the weight reaction at this point is decreased by $\frac{24EIf}{l^3}$. The two end supsupports are each increased by half of this amount in which E is the "hot" tensile modulus of elasticity and I is the moment of inertia of the pipe cross section. We may therefore write,

$$k_p = \frac{P}{f} = \frac{24\,EI}{l^3} \qquad (10)$$

as the stiffness of the pipe at support 2.

Maximum Stress

By similar exercise of the theory of three moments, the stiffness for all hanger positions in a pipeline may be determined where usually the hanger spacings vary and there are many concentrated loads, such as valves, flanges and other types of fittings. Knowing the stiffness rates k_s and k_p for each position, the percent of pipe weight transferred from each hanger to the pipe per in. of vertical shift may also be determined. With these weight transfers, it is then possible to rewrite the moment equation from which the maximum positive and negative moments can be calculated. Finally, the maximum stress is found by equating the moment which is numerically larger to $\frac{\pi}{32}(D_o^4 - D_i^4)\,S$, in which S is the maximum stress.

The work just outlined is quite considerable but it may be shortened somewhat by first approximating the k_p values and if the θ (k_p/k_s) values are well up on the flat portions of the curve in Fig. 3, the percent variability of the hanger may be taken as the value, numerically, of the weight transfer. The work may be eliminated entirely where hangers having a percent variability equal to zero are used, that is, constant-support instead of variable-support.

To reduce the stresses due to weight transfer "cold-springing" is sometimes practiced. The effect of cold-spring is to reduce the effective vertical shift, that is, for 50% cold-spring the effective vertical shift in equation (1) would be equal to $\varepsilon/2$ instead of ε.

Therefore in computing the amount of pipe weight transferred from the hanger to the pipe as expressed by equation (1) under the assumption of 50% cold-spring, ε is merely halved and the "hot" value of k_p retained. Under the assumption of 100% "cold-spring" the full value of ε is retained but the "cold" value of k_p is used.

Summarizing the step-by-step procedure in design of a high-temperature pipe-line suspension:

(1) Determine the weight reactions and weight-supporting capacities of all hangars for the locations given on the drawings under the assumptions that the sum of all weights and weight-supporting forces, including the terminal reactions, is equal to zero, and that the sums of the moments of these forces about both the x and y axes are also equal to zero. This operation should be done in any type of pipe line suspension, whether there is any thermal expansion in the pipe or not or whether rigid, variable-support or constant-support hangers are used.

(2) Determine the vertical shift, ϵ, the two lateral shifts and the stiffness of the pipe, k_p, at each hanger position. For constant-support hangers, k_p calculations are not necessary.

(3) Make certain that hanger design permits lateral shifts to take place freely.

(4) Selecting a percent variability, V, (governed by hanger design, particularly over-all height and vibration), calculate the weight transferred from each hanger to the pipe, taking into account cold-springing if any. If no cold-spring is employed, calculate weight transfers by equation (1) using the "hot" value of k_p. For 50% cold-spring, use equation (1) but divide ϵ by 2, and retain the "hot" value of k_p. For 100% cold-spring, use equation (1) and the full value of ϵ but the "cold" value of k_p. Since in constant-support hangers V equals zero, none of the foregoing calculation is necessary; the only stresses due to weight will be produced by sagging and not by weight transfer.

(5) From the weight transfers, determine maximum stress in the pipe by the theory of three moments. For constant-support hangers, a simple calculation for sagging between supports is sufficient.

(6) Combine weight-transfer and sagging stresses with expansion and internal-pressure stresses, bearing in mind that, for 100% cold-spring, weight-transfer stresses do not exist when "hot." Expansion stresses are those produced by thermal expansion under external restraints with weight ignored.

(7) Compare the maximum stress just determined with the safe maximum working stress of the pipe material at operating temperature under service conditions including vibration and corrosion.

Examples Computed

Applying the foregoing principles to the simple riser shown in Fig. 6, maximum stress due to the combined effects of weight transfer, sagging and internal pressure have been computed for 6- to 24-in. pipe when supported by variable-support and constant-support hangers under the following conditions:

(a) total temperature of 750 F, 850 F, and 950 F, pressures 400 to 1600 lb per sq in. and in the case of variable-support a cold-spring of 50% and a variability of 19½%,

(b) same as (a) except with no cold-spring,

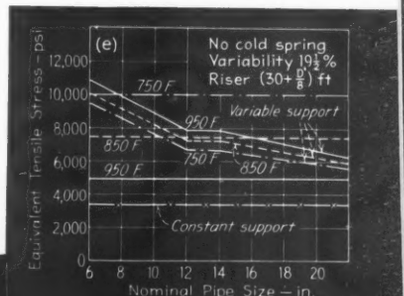
(c) same as (a) except with 100% cold-spring,

(d) same as (a) except with no cold-spring and a variability of 100%,

(e) same as (a) except with no cold-spring and a riser length of $\left(30 + \frac{D''}{8}\right)$ ft. ft instead of $\left(60 + \frac{D''}{8}\right)$ ft.

Curves for each set of conditions, Fig. 7, are averages for pipe schedules 40–160 inclusive (ASA) there being very little deviation from the average in all cases. The safe maximum stresses of 10,000 psi for 750 F, 7500 psi for 850 F and 4000 psi for 950 F are based on pipe material conforming to A-106-36 (Grade A Seamless Steel Pipe), the ASTM specification which calls for a

(Continued on page 184)



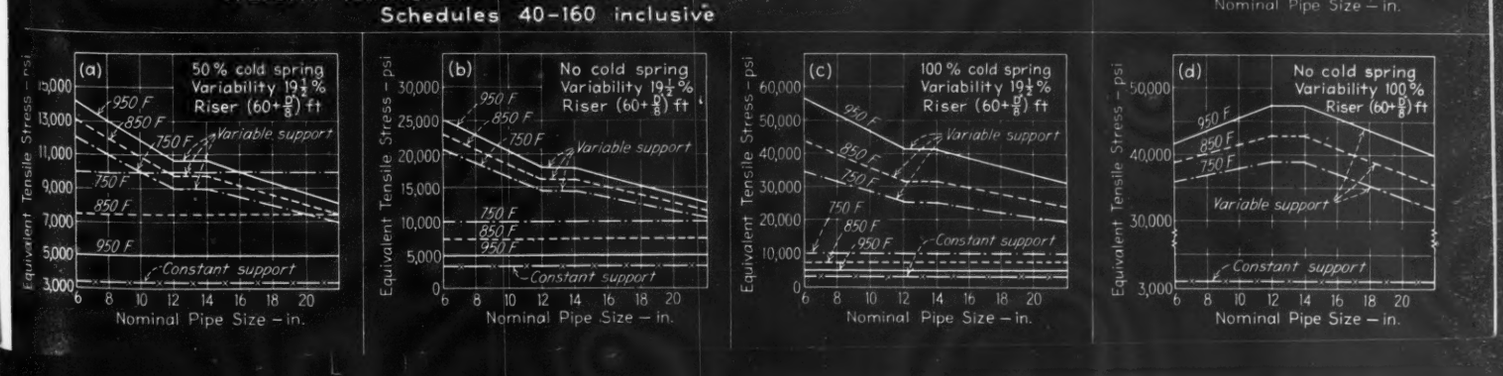


Fig. 7—Stress in pipe riser of Fig. 6

What Makes a Good Steam-Engine-

William G Forbes, formerly staff engineer and technical writer on lubrication, Socony-Vacuum Oil Co, answers this question by going back to the beginning and describing how the various classes of steam-cylinder oils are made

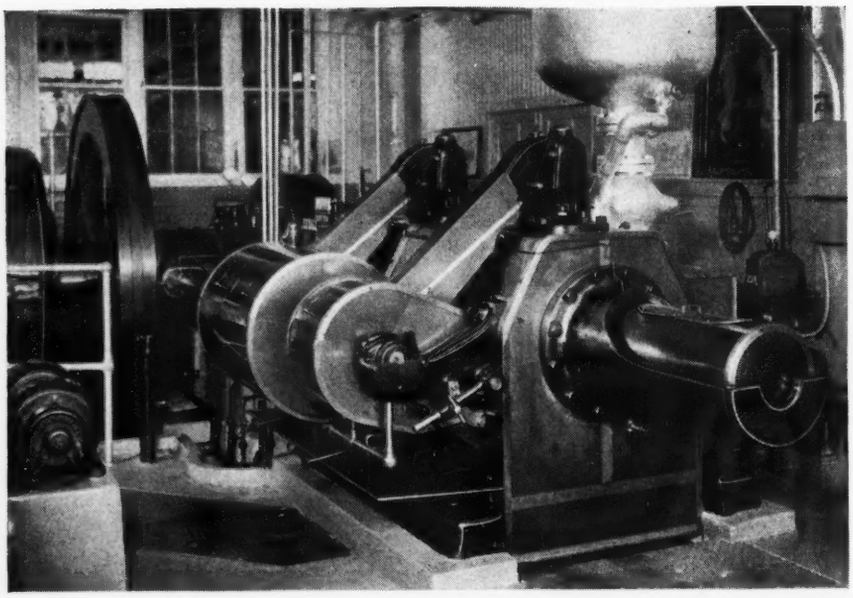


Fig. 1—Steam-engine cylinder oils, whether compounded or not, may be classified as light-bodied, medium-bodied, heavy-bodied, and very heavy-bodied

▶ LUBRICATION of reciprocating-engine cylinders and valves embraces a certain element of mystery for many engineers. This is not surprising because experienced lubrication engineers are sometimes puzzled when anticipated results are not realized from a particular brand of cylinder oil. If operating conditions are unusual it is often a matter of trial and error to arrive at a satisfactory recommendation.

Fundamental principles of steam-valve and -cylinder lubrication are not difficult to understand for most steam engines. An essential is the process by which steam-cylinder oils are produced.

Distillation Process

After crude oil is taken from the well, the various products, such as gasoline, kerosene, fuel oils, light lubricating oils, etc, are separated by the simple process of distillation. When heat is applied to crude oil, vapors are driven off and condensed. Large scale distillation is carried out in a fractionating tower, Figs. 2 and 3, which, as the name implies, sorts out the distillates automatically as they rise and condense on trays.

Unlike water which boils at one definite temperature depending upon pressure, all petroleum products have what is termed a boiling range. For example, commercial gasoline has an approximate boiling range of 90 to 410 F, kerosene 350 F to 525 F and so on, until we reach the cylinder stocks which have a boiling range of 625 to 825 F.

Figs. 2 and 3 show how continuous distillation is done in a refinery. As the hot vapors rise, they become cooler and a certain amount condenses on each tray until the tray is full of liquid to the level of the overflow. This level is maintained above the edge of the bubble caps so that all vapors must pass through liquid. Each tray is cooler than the one below it; therefore, the lightest products condense out at the top and the heavier ones on the lower trays as the vapors struggle to the top of the column. At certain points, the condensed liquids are drawn off, the light products at the top and the heavier ones from the lower trays.

After the light products have been distilled from the original crude the residue, known as topped crude, becomes the source of all steam-cylinder oils. When the topped crude or undistilled residue is suitable for the manufacture of cylinder oils, the distillation process is continued, Fig. 3. Distillation of this heavy residue must be done at increasingly higher temperatures. To obtain cylinder stocks at the lowest possible temperatures and to prevent damage to the oil from overheating, distillation is done in a vacuum. Generally, the heavy residue is heated by steam coils except in some cases where superheated steam is mixed directly with the residue. The final result is the same, however—cylinder stocks of light, medium and heavy body are obtained.

Cylinder stocks are also processed to remove undesirable materials such as wax which must be partially or entirely removed, so that the finished product will flow at temperatures of 40 to 50 F. There are several dewaxing methods in common use but they all depend upon refrigeration to solidify the wax and assure its removal in a filter. Upon completion of the dewaxing process some of the Pennsylvania stocks become finished products ready for use as steam-cylinder oils.

Removing Impurities

When other materials such as asphaltic bodies are present in the heavy residue they are removed in various ways. One method is to mix the oil with sulphuric acid which causes an asphaltic sludge to settle. Upon removal of this sludge, sulphuric acid is washed out of the purified oil by water. Then the water is removed and the oil processed with an alkali such as caustic soda to neutralize and remove remaining traces of sulphuric acid.

Another method of removing asphaltic substances, now in common use, is known as solvent extraction. Whatever the method employed to produce finished cylinder oils, they are known

Cylinder Oil?

in the commercial market as Pennsylvania steam-refined stocks, mid-continent steam-refined stocks, etc. They form the bulk of the steam cylinder oils in use on engines today.

Another step is filtering the original steam-refined oils through fuller's earth. This extra filtration process removes some of the coloring matter, but much more important, it lowers the carbon-forming content of the oil. Another important feature of the filtered stock is its improved ability to separate from water, a desirable characteristic when the oil is used in condensing engines. Cylinder oils of this type are known as "filtered cylinder stocks."

"Bright Stocks"

The premium grades of steam-cylinder oil are known as "bright stocks." They are manufactured from the best crudes and are carefully filtered through fuller's earth. The term bright stock is derived from a characteristic appearance, which may be described as a golden color. "Bright stocks" have a low-carbon forming content, and separate readily from water. They are particularly important because they meet the special requirements of condensing engines and high-superheated-steam conditions. In the commercial market these oils are designated as Pennsylvania bright stocks, mid-continent bright stocks, etc, depending upon the source of the original crude from which they were manufactured.

From this brief outline of fundamental refining principles it is obvious that the quality of steam-cylinder oils must vary. Unfortunately, no simple rule of thumb or handy instrument has yet been devised to gage accurately the quality of a particular steam-cylinder oil. The best and only guide in the hands of the average purchaser is that of the service results secured and reliance upon the integrity of the supplier.

Know Your Oils

The user should have, however, a practical knowledge of the different types of steam-cylinder oils available in order to form an intelligent opinion on steam-cylinder lubrication problems. Each oil type has its place and often certain characteristics are most important.

The next consideration in arriving at a better understanding of steam-valve and -cylinder lubrication is to follow the process of compounding and the reasons therefore. The two principal oils used for this purpose are tallow oil and degras. These additives cause mineral oils to emulsify in the presence of water. Thus, when water or moisture is present on the rubbing surfaces within a steam engine, a tenacious and durable oil film is formed by the oily emulsion.

Without compounding, a pure mineral oil dislodges easily if moisture flows over the valve- and cylinder-wall surfaces. Hence, compounded oils are employed wherever possible. Tallow oil is manufactured from animal fats and as employed in steam-cylinder oil, is known as first grade, or No. 1, acidless tallow oil. Degras, refined from the fatty content in sheep's wool, has better emulsifying qualities but does not stand heat as well as tallow oil.

Generally, degras is not used for steam pressures above 125 lb gage. Tallow oil is the emulsifying agent in the great majority of compounded steam-cylinder oils. Roughly speaking, all compounded cylinder oils contain from 2 to 10% tallow oil. Some may contain up to 14% where tallow oil and degras are used in combination. The higher the percentage of compounding the more readily the oil emulsifies with water.

Compounding is generally done in the refinery at a temperature of 120 F and the process is very simple, like mixing salt with water. Cylinder oils become saturated when the amount of compounding reaches 14%. A higher percentage is impractical because the compounding settles out at ordinary room temperatures.

Strange things can happen to compounded steam-cylinder oils if they are not stored in reasonably warm surroundings. Low temperatures will freeze the tallow oil into crystalline structures. Many an oil-company representative has been summoned to a plant to view a newly opened drum that appeared to contain a substance resembling ground glass. If any of the compounding has settled out, just leave the drum in a warm place for a day or two, then roll it on the floor. This will cause the tallow oil to go into solution again and no harm will be done,

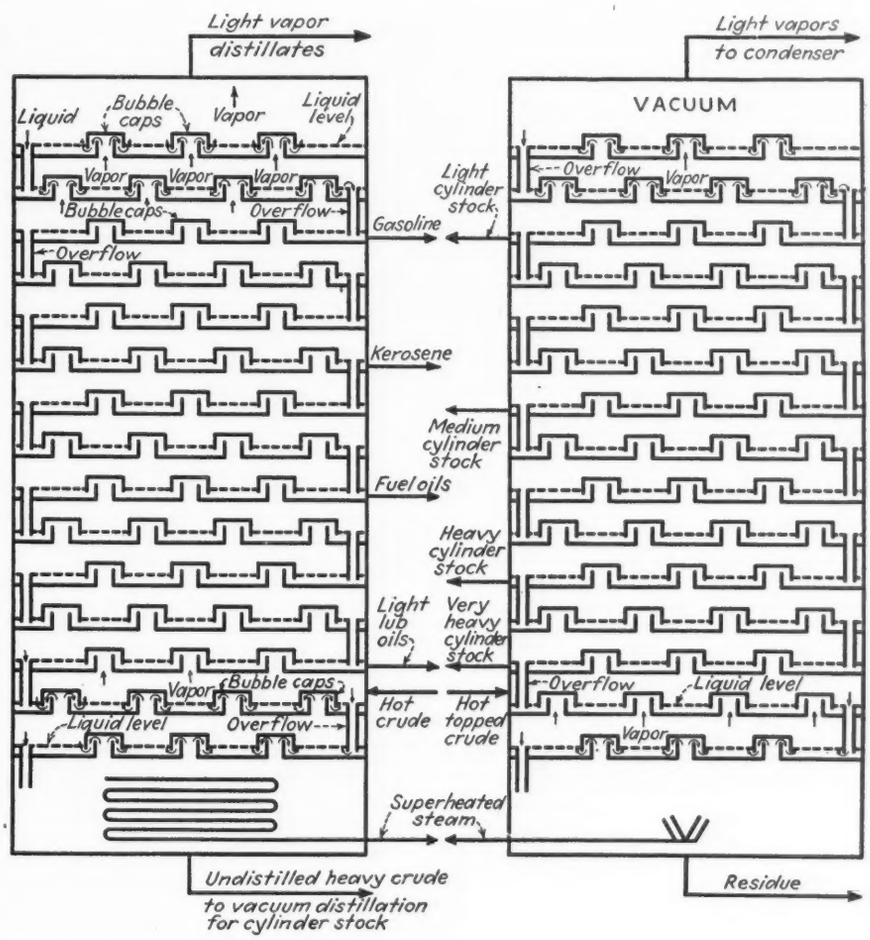


Fig. 2 (left)—Diagram of distillation tower shows how lighter distillates are obtained from crude oil. Fig. 3. Diagram of vacuum-distillation tower where steam-cylinder stocks are obtained from heavy residues left from the distillation process, Fig. 2

providing the freezing has not been too severe.

Cylinder oils, whether compounded or not, may be further classified as light, medium, heavy, and very heavy bodied. In terms of Saybolt viscosity readings, this classification range may be taken as comprising cylinder oils of 100 to 250 sec at 210 F. Viscosity readings give the lubrication engineer a convenient yard stick from which he reads the body or flow characteristic of a particular cylinder oil and thereby gages its adaptability to a particular steam-temperature condition. Viscosity, however, has no bearing on quality.

To those not familiar with viscosity terms, the test is a measurement of rate of flow. In this country the standard instrument is known as a Saybolt viscometer. A measured quantity of oil is placed in a container and heated to a temperature of 210 F. The charge is then allowed to run through a standard size orifice and the time taken to empty the container is clocked in seconds. For example, a reading of 100 to 125 sec would indicate a light-bodied steam cylinder oil, 125 to 150 sec medium body, 150 to 200 sec heavy body. The very heavy-bodied cylinder oils (those above 250 sec) are seldom used in steam-engine cylinders.

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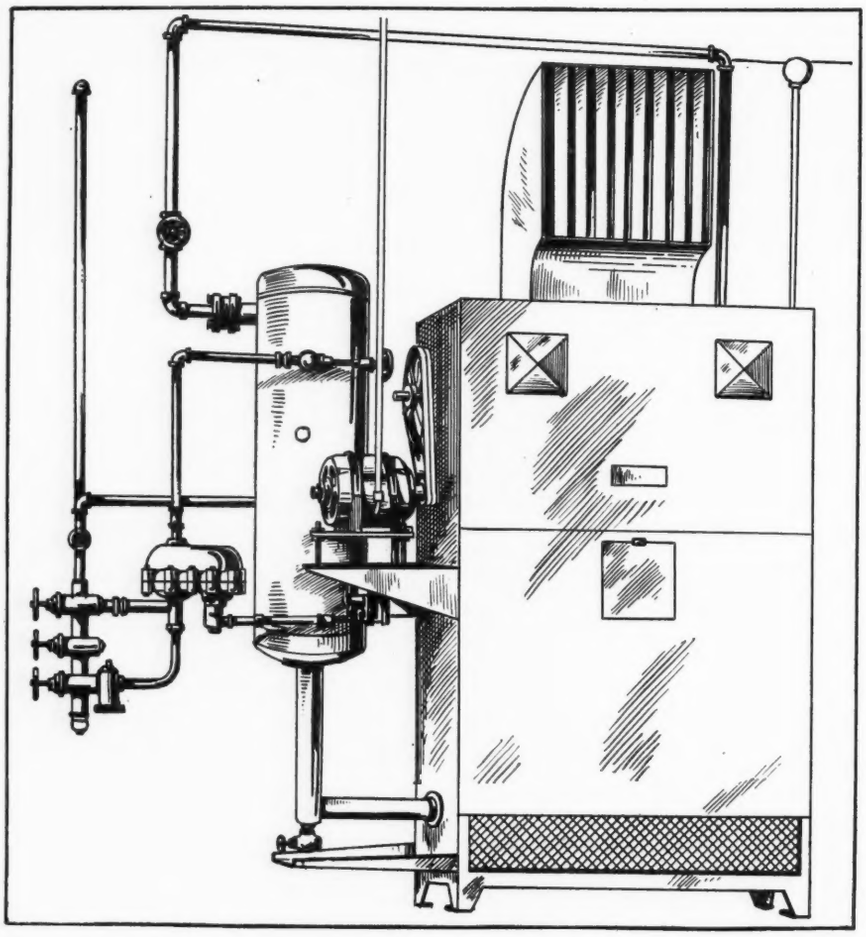
New Refrigerating Methods for Old

C T Baker, Atlanta consulting engineer, shows how unit coolers, recently applied to ice-cream hardening rooms, save space, remove heat rapidly, and bring ease of control and defrosting



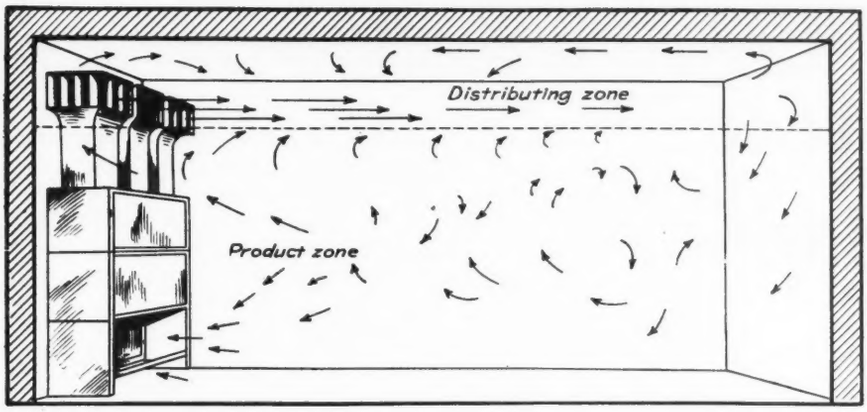
Typical unit cooler for ammonia service, showing accumulator and float valve control

▶ ICE-CREAM MANUFACTURERS use large amounts of refrigeration, for freezing and hardening, for cooling the mix, and for maintaining proper temperatures in rooms where ingredients are stored. The hardening room constitutes a major demand; ice cream from the freezer remains there, at –20 F, or lower, until hardened. Recent experience shows that unit coolers can handle this cooling job, and that they possess certain advantages over other common arrangements.

For many years, pipe-coil evaporators, placed directly in the room, did the hardening, or the coils were placed in a bunker loft above the room, with a motor-driven fan to deliver cold air to the hardening room and return warmer air to the bunker. In more recent years, these arrangements gave way to coils placed directly in the hardening room, usually built up in the form of pipe shelves to form supports for the cans of cream to be hardened.

While such cooling-coil designs have been used for years and have proven capable of maintaining the required temperature, they possess certain disadvantages. Coils placed directly in the hardening room take up space that could be used for storage. Most evaporators of this type operate flooded, which calls for a heavy charge of ammonia. It is always a lengthy process to pump out such coils when repairs are necessary. Often a greater problem arises—finding storage space for the liquid during the time the coils are off the line, since generally the liquid receiver won't hold safely all liquid removed from the coils. Finally, the job of defrosting crops up and there is no simple solution unless it is practical to use hot-gas direct from the compressor.

During the past two years, unit coolers have been successfully applied to hardening-room cooling and, where correctly fitted to the cooling demands,



Unit cooler produces complete distribution and good circulation of air

have demonstrated certain points of superiority over orthodox methods of refrigerating the hardening room.

First, they occupy less space than shelf coils. In addition, they provide rapid air circulation throughout the room, thereby removing heat from the cans and cartons of cream more rapidly than would be possible with natural air circulation due solely to gravity. A fan, usually an integral part of the unit cooler, secures this latter advantage.

The construction of floor-type unit coolers permits easy access to all parts including motor, pipe connections, and controls. A galvanized metal casing, usually 16-gage steel, encloses the coils. Since ammonia is the refrigerant, coils are usually steel; either plain ¾-in. pipe, full weight, or fitted with 3 or 4 fins per inch of length, to provide additional heat-absorbing capacity.

An advantage of unit coolers using ammonia lies in the simplicity of float control for flooded operation. Such automatic control, accomplished by a float-actuated liquid valve adjustable to maintain any desired liquid level, insures maximum effective cooling. A suction trap on the gas outlet of the coil collects any ammonia that may pass from the coil with the suction gas, returning it to the inlet.

Frequently, a magnetic liquid valve is placed in the liquid line and connected to a thermostat which closes when room temperature falls to the desired point and opens when temperature rises to the maximum allowable upper limit. Where a compressor operates on one unit, the thermostat is connected so that it will close the magnetic liquid valve and stop the compressor also, the compressor being started when the temperature rises to a given point.

To defrost unit-cooler coils requires only a connection between coils and liquid-feed point, permitting discharge gas from the compressor to enter the coils near the bottom. A hand stop valve in the liquid leg, between the liquid trap and the hot-gas connection, prevents the gas going anywhere but directly to the coils. A removable pan below the coils catches the melting frost, later removed in the form of ice. This method of defrosting assures simple, quick, and complete removal of frost accumulations.

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Exhaust Lines

By L N ROWLEY

Engineers with slagging problems may want to try a method of deslagging recently reported by Dipl Engr E Schumann, of the Industrial Inspection Association, Essen. Boiler operators expose slag to ammonia-laden vapor, obtained by passing steam through a 20–25% aqueous solution of ammonia. Depending on thickness, 5 to 20 hours are needed to loosen slag enough for it to fall of its own weight, or to be easily removed by hand. The method has been reported successful on 50 different boilers in the Ruhr district, and is said to leave metal surfaces clean and bright, with no harm done to settings.

Two new 900-ton compressors, installed in the RCA Building in April, make the air-conditioning system at Rockefeller Center the world's largest for human comfort in a commercial development. These giant units bring total capacity to 6800 tons.

Devotees of detective fiction, familiar with the sinister aspects of firearms fitted with silencers, don't usually realize that it was just this angle that caused the authorities to discourage production of the silencer invented by Hiram Percy Maxim, after it had come into wide use among sportsmen and had been adopted by the U S Army. And to this turn of fortune we owe the wide adaptation of silencing principles to compressors, diesels, and other industrial equipment, for the Maxim Silent Firearms Co dissolved to form the Maxim Silencer Co, aimed at developing industrial silencing.

In a recent number of LIFE, *James T Robbins relates the fascinating story of the Kembs dam. This is on the Rhine, but the power plant lies on the French side with most of the customers in Germany. Taking the call to war literally, the French cut off the current, but shortly received polite notice that their German customers were anxious to keep on taking service and paying bills. Being a realistic race, the French put the deal through quietly, and everybody's happy.*

A different twist marks the story of the twin villages at the French-German border, near Luxembourg. This time the Germans held the light plant, and they also took their war seriously at the beginning and cut off power to the French village. The impatient French promptly shelled the German village. After a few hours, the current came on and the shelling stopped. A few weeks ago, there was another service interruption but before 10 minutes passed a German loudspeaker went into action. "Please restrain your fire", said a voice in French, "the cutting of the current is due, not to political, but to purely technical reasons". The French did "restrain" and sure enough, within two hours they were again enjoying free German electricity.

"Heating tower" looks funny in print, but think of a cooling tower in reverse and you have a rough idea of a smart device for snaring Btu's. According to HEAT ENGINEERING, *the Upson Co and the Gair Co of Canada lead warm moist air from paper-machine hoods to towers where it gives up heat to water cascading down the filling members. Many uses exist for the warmed water around a paper mill, including de-icing logs.*

In a steam generator recently granted a British patent, a variable-speed fan delivers controlled amounts of flue-gas to the furnace, to regulate superheat temperature without changing rate of firing. The fan picks up gas after it passes a convection superheater, a reheater, economizer, and air heater. Adding returned products of combustion lowers furnace temperature, decreasing heat transfer to waterwall tubes but markedly increasing weight of gas passing superheater surface and so producing required steam temperature without excessive gas temperatures at the superheater elements. This scheme also produces a higher reheat temperature.

Air Preheaters for Heat Balance

Boiler-room heat balance in modern high-pressure plants would be much less favorable without air preheaters. This review starts at beginning with what, where, why and how

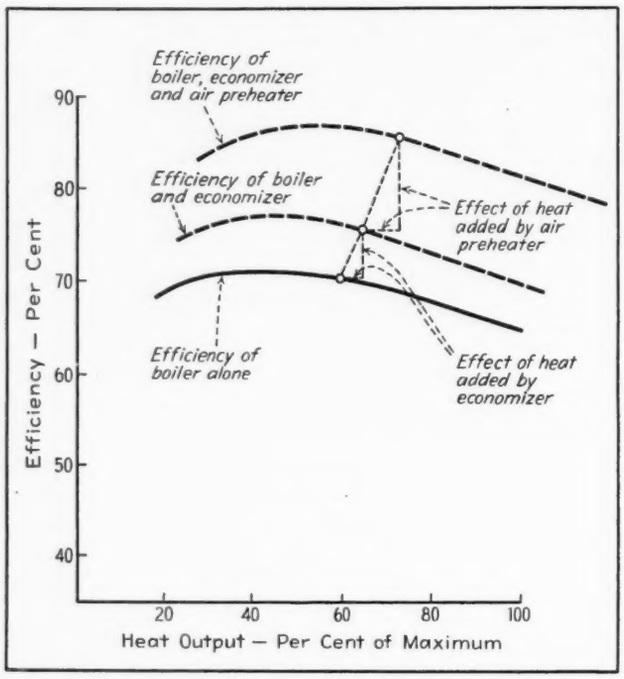


Fig. 1—Steam-generator efficiency curves show how economizer and air preheater increase output as well as efficiency

▶ OTHER FACTORS BEING EQUAL, the boiler plant with the lowest flue-gas temperature has the highest efficiency. Air preheaters can bring stack gas to a lower temperature than any other type of heat-recovery device and so have become an integral part of boiler-room heat balance in practically all new high-efficiency designs.

Plants for lower pressure, or lower load factor, may rely only on the one or the other; the economizer is the favorite (economically) for industrial steam generation if stoker fired; air preheaters supply heat for drying coal during pulverization, and represent least costly installation of equal efficiency for pulverized-coal, oil, and gas fuels under usually favorable conditions.

An air preheater is simply a device for transferring heat from outgoing flue gas to combustion-air supply. Heat so recovered is returned to the furnace and effects an increase in boiler output exactly as though utilized directly in raising feed temperature or evaporating steam. A good rule of thumb is that 40 F reduction in flue gas temperature increases output and improves efficiency about 1%.

The effect of an air preheater on boiler efficiency is graphically illustrated in Fig. 1. The efficiency curve for boiler alone, without heat-recovery apparatus, is usually plotted against heat output or steam flow. Since economizer and air preheater, either or both, increase the output without change in input, the condition for any firing rate of fuel-burning equipment is represented by an increment of output as well as an increment of efficiency, as indicated schematically by the sketch.

Heat Recovered by Preheater

Another conventional method of representing heat balance of a steam generator is shown in Fig. 2. This sketch illustrates the simple fact that all the heat recovered (minor losses excepted) appears in the steam output. It does not, however, take into account air-preheater leakage or radiation from ducts.

Air preheaters introduce additional resistance in the flow paths of both flue gas and combustion air. Depending, of course, on the size and arrangement of preheater and ducts, these losses may be from one to three inches water gage. They are usually impractical for natural-draft operation. Also, any economic evaluation of net dollar savings from use of preheat must take account of increased fan power which, depending on temperature, ranges from 0.7 to 1.0 kw per inch of draft loss per 10,000 lb per hr of gas flow plus about 0.5 kw per inch pressure drop for equal flow of air. For a first approximation, 10 degrees of flue-gas cooling will provide the heat equivalent of fan power for 1-in. pressure loss

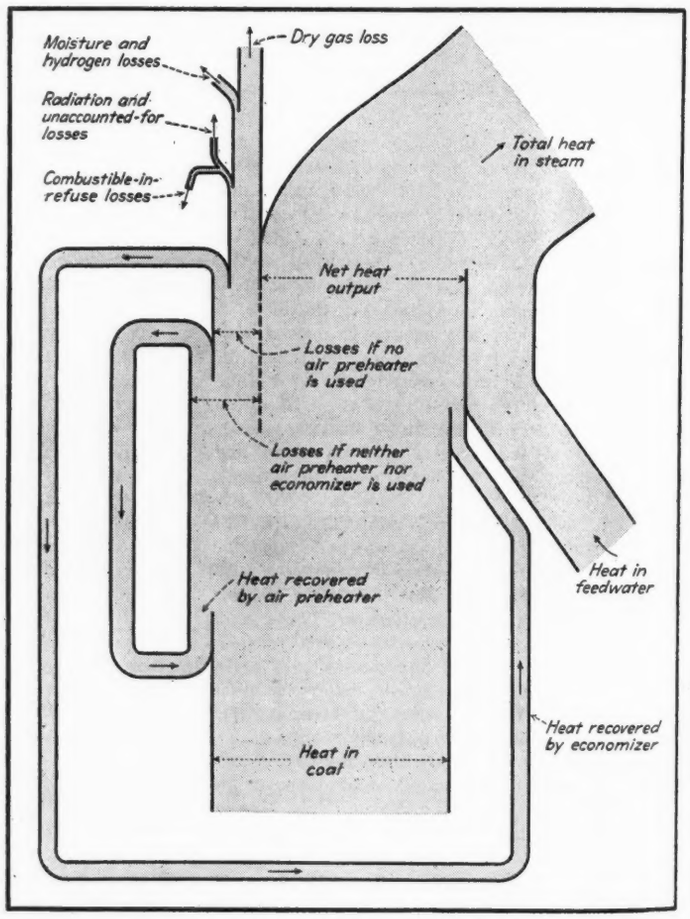
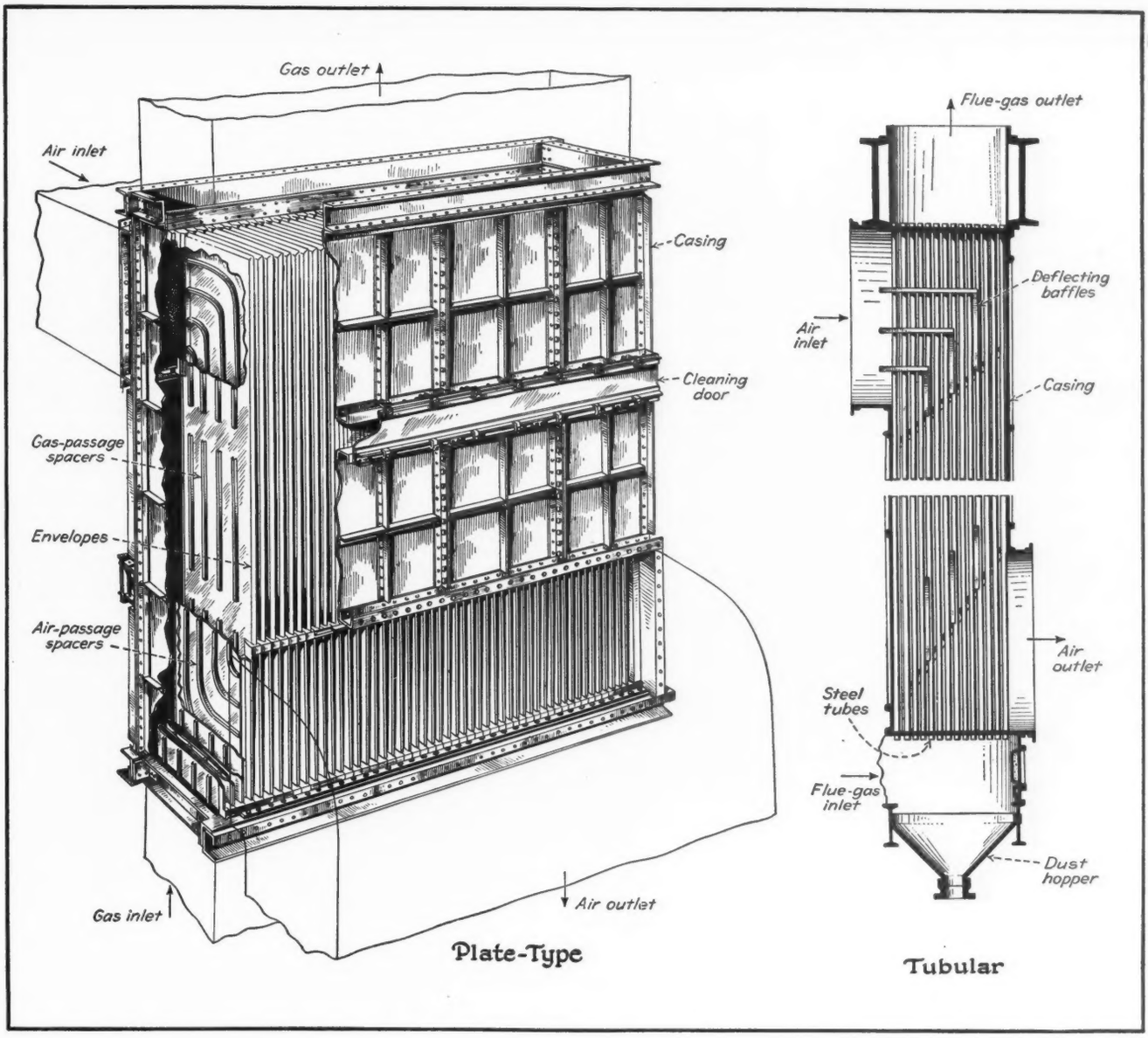

Moisture and hydrogen losses
Dry gas loss
Radiation and unaccounted-for losses
Total heat in steam
Combustible-in-refuse losses
Net heat output
Losses if no air preheater is used
Losses if neither air preheater nor economizer is used
Heat in feedwater
Heat recovered by air preheater
Heat recovered by economizer
Heat in coal

Fig. 2—Air-preheater heat recovery flows back into the furnace and is ultimately converted into sensible heat in steam



for both forced- and induced-draft fans.

For pulverized-coal installations, preheated air is admitted to the mill to remove moisture from the coal during pulverization. It is usually tempered by mixing with cold air so that the fuel-air mixture leaves the mill at 120–150 F. Secondary-air temperatures range up to 550 F. In general, the hotter the air at the burner, the better the ignition and flame control. Use of preheated air with oil or gas fuels or most waste fuels offers no problem. For coal on stokers, however, air temperatures are usually limited to 300 F to avoid burning stoker iron, so that possibilities of increased efficiency from preheated air are limited.

Proportioning an air preheater for a given installation requires study of several factors. First, space limitations for the preheater itself may limit size. Second, the higher the flue-gas temperature and the higher the load factor, the greater becomes the justifiable amount of air preheater surface. Note that duct size is not appreciably affected by size of preheater and induced-draft fan size may actually be reduced by increase in preheater surface due to cooler gas entering the fan.

Temperature Limit

An economizer obviously cannot cool flue gas below the temperatures of incoming feedwater; an air preheater has no such limitation and can be safely operated at exit temperatures below 300 F. One authority gives the following rule: no *metal part* of the preheater shall operate for any appreciable period of time at a temperature below 150 F plus 20 F for each percent of sulphur in the fuel. Metal temperature ranges about halfway between that of exit gas and inlet air, but may be lower in local spots due to uneven distribution of gas and air flows. Any condensation of moisture on heat-transfer surfaces leads to serious plugging and probable corrosion of flow passages.

Preheater surface is obtainable at low unit cost, about a third of the cost of economizer surface. However, it should be understood that relatively large amounts of preheater surface transfer relatively small amounts of heat as compared with boiler convection surface, for example. This is true because the temperature difference or "heat head" in the preheater is less than in any preceding section of the steam-generating unit. Mean temperature differences range from 150 to 250 F. In some new installations preheater surface in sq ft exceeds that of boiler, water walls, superheater and economizer combined.

Compactness and low cost per unit of surface are therefore prime considerations in preheater design. If air preheaters and economizers are installed in series, with relation to the flue-gas flow,

the air preheater follows the economizer except in a few special cases. Also, air preheaters are invariably arranged for counter flow, that is, entering air passes over heat-transfer surface near the flue-gas exit.

Three types of preheater construction are in common use: plate, tubular, and regenerative. The first is made up of a number of envelopes each fabricated from two steel sheets of about 12-gage thickness. Edges are usually sealed by welding, with openings left for passage of air in and out of the envelope. A number of such envelopes stacked with appropriate spacing (½ to 1 in.) forms a unit with alternate air and gas spaces. Large areas of metal are thus exposed to thin gas and air streams, making for compactness and low cost.

Plates of one manufacturer's design are spaced by separators which also serve to guide the air and gas flows. Another design passes the air back and forth several times at right angles to the general direction of the gas flow. Return-bend ductwork reverses the direction of air flow at the end of each pass. The latter arrangement allows installation of soot-blower elements between sections of the preheater, but air pressure loss is increased.

Tubular Preheaters

Tubular preheaters consist of a number of thin-wall steel tubes from two to three inches in diameter welded or rolled into tube sheets at inlet and outlet. They are usually set vertically with flue gas flowing upward through the tubes. This prevents dust or flyash from plugging the tubes, but fouling occurs with some fuels. Soot blowers are not effective and cleaning requires shutdown. Tubular preheaters cost somewhat more and require more space than plate-type units.

Regenerative preheaters, of which the Ljungstrom design is the only one in common use in this country, employ a moving rotor, part of which is continuously being heated in the gas stream while another part is giving up its stored heat to the air. The rotor is made up of a large number of crimped steel plates assembled in a welded cage. The rotor is driven at about 3 rpm by a motor drive bevel-geared to the shaft.

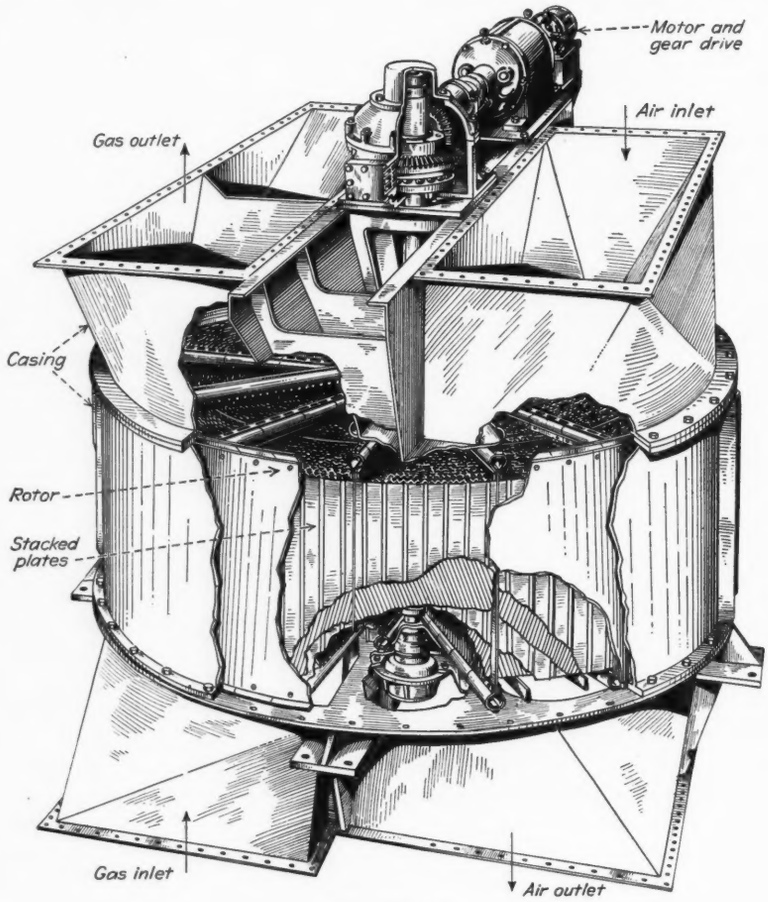
A large proportion of recent installations have been regenerative. These are more compact for a given heat recovery than other designs, particularly in large sizes. Flue-gas and air ducts enter and leave parallel with each other which usually results in minimum space occupancy. Also, for a given gas flow, increased heat recovery is obtainable at the slight expense of higher rotor plates without appreciable increase in total space occupancy.

Operating troubles with preheaters fall in two general classes: (1) plugging of flow passages with soot, fly-ash or cinder, and (2) corrosion of the cold end of plates, tubes or rotor stacks.

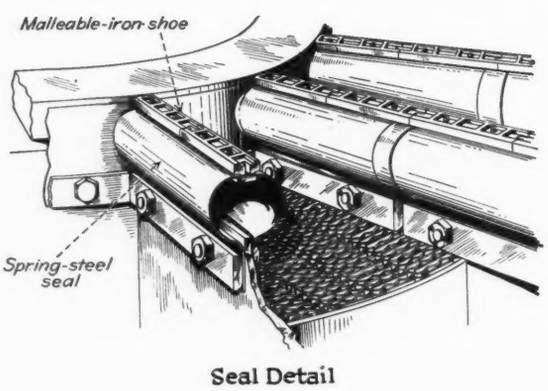
Plugging can occur due to several causes. Stoker cinder of large size can actually bridge the openings. Soot or slag blowing with steam or water can result in moisture being carried through to the preheater to start a sticky accumulation. Operation at low load, or frequent starting and shutdown, can increase the period of low temperatures prevailing in the cold end of the preheater.

Plate-type preheaters suffer most from plugging as spaces are narrow and dead spots in the gas flow more apt to occur. Soot blowers or scraper chains have been found reasonably satisfactory remedies. Regenerative preheaters have less tendency to plug as long as the soot or flyash is completely dry because of the sweep of high-velocity air backward

(*Continued on page* 156)



Regenerative



Seal Detail

Simpler Operation for This Flue-Dust Sampler

For ease of sampling in terms of field and laboratory procedure as well as minimum cost, says P H Hardie, Consolidated Edison Co of New York, this equipment has better metering and flow control than design reported in April POWER

▶ NEITHER A MICRO-MANOMETER nor a barometer are a necessary part of the minimum-cost dust sampling device illustrated below. It is also believed that the arrangement here shown is less costly and requires less of an operator's time both in field and laboratory than the sampler described in April POWER.

Instead of bubbling bottles, the dust is separated first in a high-efficiency cyclone separator and then in a fritted-glass filter. By this means the dust is removed in a dry state which greatly reduces the work of obtaining its weight. From the filter the sampled gas passes through a flow-regulating valve, moisture trap, rotary motor-driven compressor, gas meter and orifice for indicating the sampling rate. Different size nozzles are provided for the inlet end of the sampling tube so that the quantity of gas passing through the apparatus can be kept within limits for ease and accuracy of testing even for widely differing flue velocities.

Pitot-tube and orifice-pressure leads are connected to duplicate inclined draft-type gages. A separate orifice is provided for each size of sampling nozzle. The ratio of orifice area to nozzle area is made such that the gages read the same if the same velocity is being maintained through the nozzle as exists in the flue at the point of sampling. The relationship between pitot-tube velocity pressure and orifice differential is:

$$H_0 = \left(\frac{A_n}{C_0 A_0}\right)^2 \frac{P_{sf}\,(t_o + 460)}{P_{so}\,(t_f + 460)} \times P_{vf}$$

where H_o = differential pressure across orifice, in. water (vertical)

p_{vf} = velocity pressure in flue, in. water (vertical)

A_n = inlet-nozzle area, sq in.

A_o = orifice area, sq in.

C_o = orifice coefficient

P_{sf} = static pressure in flue, in. H_g abs

P_{so} = static pressure at orifice, in. H_g abs

t_f = temp of gas in flue, F

t_o = temp of gas at orifice, F

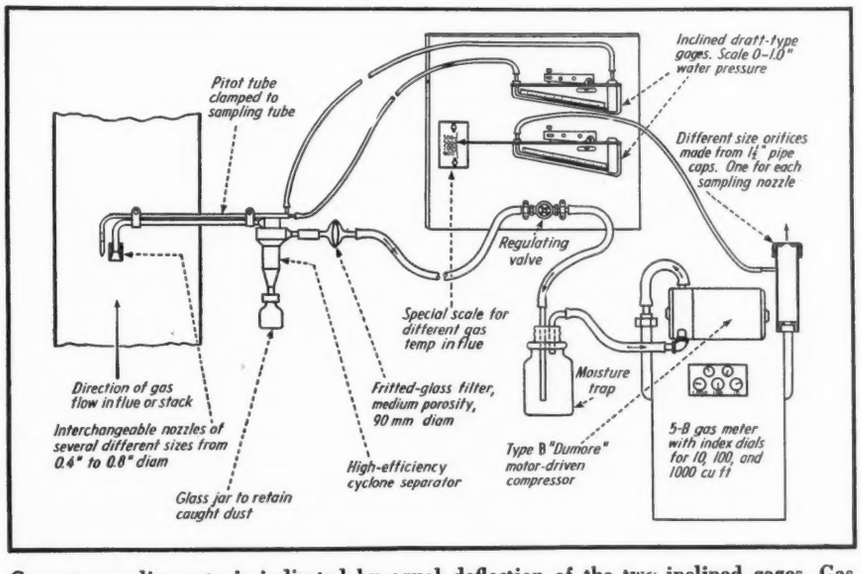
If $H_o = p_{vf}$, then

$$\frac{A_0}{A_n} = \frac{1}{C_0}\sqrt{\frac{P_{sf}\,(t_o + 460)}{P_{so}\,(t_f + 460)}}$$

The temperature at the orifice is always within a few degrees of atmospheric and can be assumed to be approximately constant. The static pressure in the flue and at the orifice are likewise sufficiently close to atmospheric to be assumed equal and constant. The orifice coefficient of discharge is virtually constant. Therefore, the temperature in the flue remains the only variable quantity.

The orifice size should be calculated for some mean flue-gas temperature, say 500 F. For other temperatures, the gage reading the orifice differential is tilted slightly to restore the equality of the readings of the gages for the correct sampling rate. To determine this change in slope of the gage glass, first compute the percentage change in orifice differential. Then by means of trigonometric tables, or merely by connecting the two gages in parallel and tilting the lower one enough to give this percentage increased or decreased reading, a temperature scale such as that shown can be made. When the inclination of the gage is changed, its zero must be reset.

The orifice differential is used for control of sampling rate only, for which the Tentative ASME Power Test Code for Dust-Separating Apparatus permits a deviation of as much as 15% from the correct sampling rate. The sampled gas is measured by the gas meter, at atmospheric pressure and temperature, eliminating all computation except the simple division of the dust weight by the quantity of gas sampled.


Inclined draft-type gages. Scale 0–1.0" water pressure
Pitot tube clamped to sampling tube
Different size orifices made from 1/4" pipe caps. One for each sampling nozzle
Regulating valve
Special scale for different gas temp in flue
Direction of gas flow in flue or stack
Fritted-glass filter, medium porosity, 90 mm diam
Moisture trap
Interchangeable nozzles of several different sizes from 0.4" to 0.8" diam
High-efficiency cyclone separator
Type B "Dumore" motor-driven compressor
5-B gas meter with index dials for 10, 100, and 1000 cu ft
Glass jar to retain caught dust

Correct sampling rate is indicated by equal deflection of the two inclined gages. Gas meter gives the integrated flow at atmospheric conditions for duration of run

Life-Size Model Tests Control Board

Full-scale model of control and meter board, built of plywood and photographs, helps visualize details and invites trial of new ideas. By H A Johnson and George Metz, Consolidated Edison Co of New York, Inc

▶ CENTRALIZING COMBUSTION CONTROL in a modern high-pressure boiler room has the effect of creating a center of activity wherever the control and its supervisory instruments are located. Often control boards are surrounded by auxiliary equipment, in the way of maintenance operations, exposed to the noise and dirt of a general boiler aisle or, if in a separate room, too far away from the equipment being controlled.

Unquestionably the comfort and convenience of control-board location and arrangement have an effect on both morale and efficiency of the operating staff. Furthermore, it is most difficult to get the best ideas of mechanical, electrical, structural and architectural engineers translated to blueprints where the objects are as indefinite as comfort and convenience. Difficulties with lighting, heating, and noise have arisen in previous installations even with careful attempts at checking all such details.

For the four new steam-generating units now being erected at Waterside, an area about 25 ft square was available for the necessary four sections of meter and control panels. All boards were designed to come within this space, forming a semi-inclosed central location with a measure of privacy and quiet.

Because of the increasing use of models in architectural and structural work, it was thought worthwhile to try a full-size model to serve as a laboratory for working out alternate ideas, particularly as to arrangement of instruments, lighting and materials.

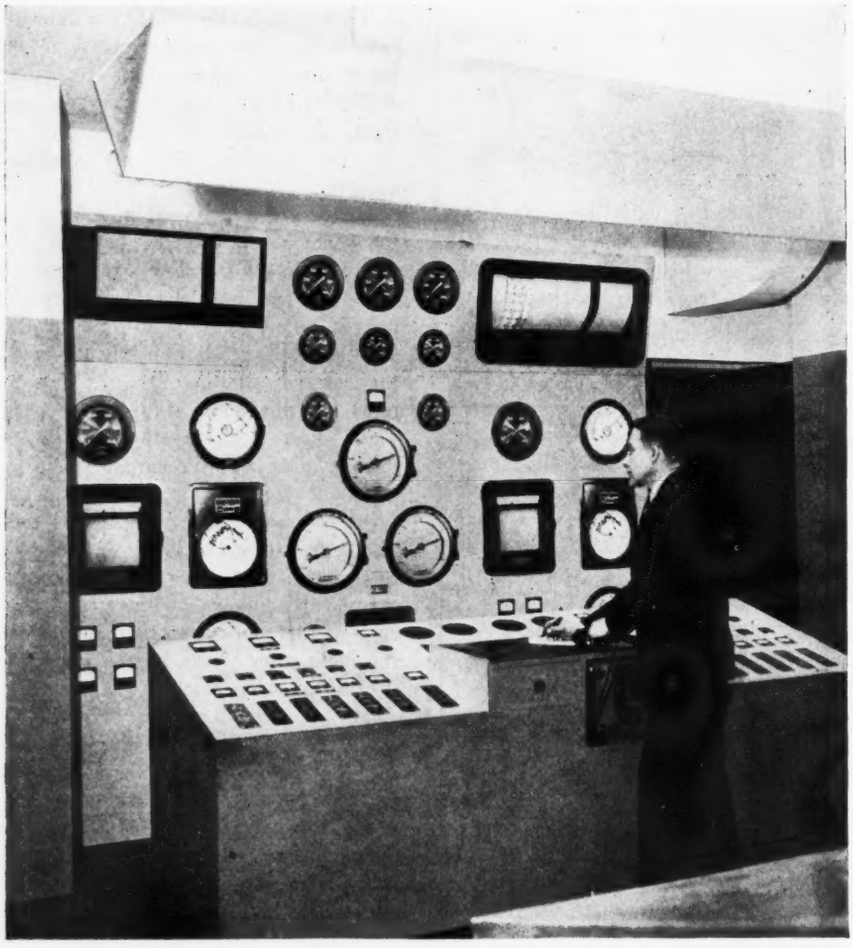


Fig. 1—Rearranging instruments and lighting, checking clearances and desk heights can be done in the model for less cost than one serious change in the final installation

Building the Model

A light-construction ¼-in. plywood model was fabricated in a few days at low cost by one of the company departments specializing in show-window sets and similar advertising display. Columns and other features of the final site were reproduced in their proper location.

Enlarged photographs, actual size, of all gages, meters and other equipment, reproduced from catalog illustrations, were applied to the finished surface in their proposed positions. Several actual instruments with glass faces were set at various elevations on the vertical board to investigate glare and highlights. Of several methods of room lighting, a totally indirect system using the ceiling area as a source of low-intensity illumination was selected. Lamps were concealed in a trough hung 2 ft below the ceiling in the center of the room.

Even with the indirect lighting arrangement, the upper part of the instrument panel had to be tipped forward slightly, as shown in Fig. 2, to clear the top instruments of reflections. Also, flat glass over the draft gages gave better results than the usual curved variety.

After some experimenting, all panels and bench-board surfaces were toned a light gray, easy on the eyes and contributing a cheerful color note to the room. All large areas of dark color were eliminated because they absorb too much light and the dark area tends to confuse the eye in its effort to adjust for rapid change from light to dark.

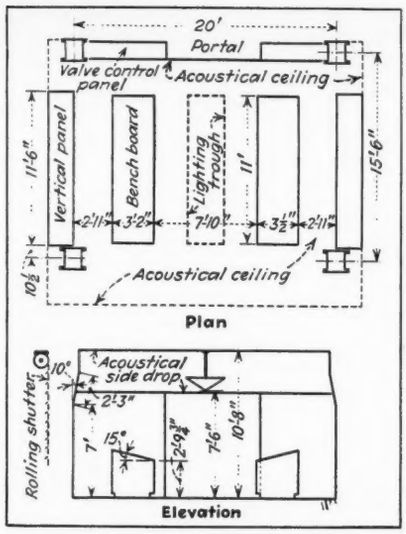


Fig. 2—Acoustical ceiling with side drops, glareless instrument lighting and convenient clearances are part of the result of model study. Note rolling shutter for access to rear of panel

Other features of the room were then finished harmoniously in contrasting shades of gray, the floor was laid in asphalt tile with alternating squares of dark gray and green.

A difference between instruments that have to be observed closely for readings, and those that need only rapid scanning was recognized. For the former, a style with black divisions on a dull silver background was selected. For scanning, white numerals on a black dial face gave quick, positive impressions with least glare. Photographic reproductions of both types were used on the model for this determination.

Results Obtained

Following the assembly of the main panels and bench boards, sample corners indicating actual materials and colors were applied. In the final installation, the columns within the area will be furred with masonry and jacketed with baked-enamel steel plate. The vertical instrument boards and bench boards will be built of panels of resin-bonded waterproof plywood approximately one in. thick faced with a ⅛-in. laminated urea-plastic sheet.

This surface, oil and acid proof, withstood every reasonable service test that could be conceived. For example, it is protected against cigarette burns by a thin lamination of aluminum sheet just below the surface layer; the aluminum conducts away the heat from the area under the cigarette so rapidly that the surface is not burned. The back of the board is also covered with the same thickness of plastic as the front to equalize any tendency to warp and to protect against the slight fire hazard of low-tension control connections. Panels and bench boards will be assembled on a steel frame, fastened invisibly from the back by short lag screws threaded on the protruding end to take a machine-screw nut.

Low Noise Level

Sound-absorbing and light-reflecting ceiling material will be carried down the side walls for several feet, forming a dome which should result in a reasonably low noise level even though the room will not be completely enclosed. If later found desirable, closure can be effected by standard sectional-partition panels, glazed with wire glass and provided with sliding doors.

Organization of the work proceeded in logical order. Architectural staff proposed details and materials of clean modern lines, free from unnecessary and inappropriate ornamental moulding, functional in design, practical, yet attractive in color. With the model set up, representing the best ideas suggested, conferences in the quiet detached atmosphere of the model site brought together all the several engineering and operating staff viewpoints and constructive criticisms.

Various positions and arrangements of instruments and equipment were exhibited, intensity of lighting changed and suggestions incorporated in the model, until finally a complete integrated layout met the approval of all. A general feeling of satisfaction now prevails that the model obviated tedious work of several groups, each checking a sheaf of blueprints. Many improvements in construction details would not have been suggested if the model had not shown so clearly and exactly what the final conditions would be like.

Furthermore, the model gave opportunity to the men who would later be the combustion-control operators of these particular boilers to play with clearances, desk heights and reaching distances; a number of corrections were made at their suggestion. The model eliminated dissatisfaction that sometimes arises from failure to visualize adequately a condition presented by blueprint only. Busy executives also used the model to gain a quick impression of the contemplated layout without the need for studying drawings and blueprints.

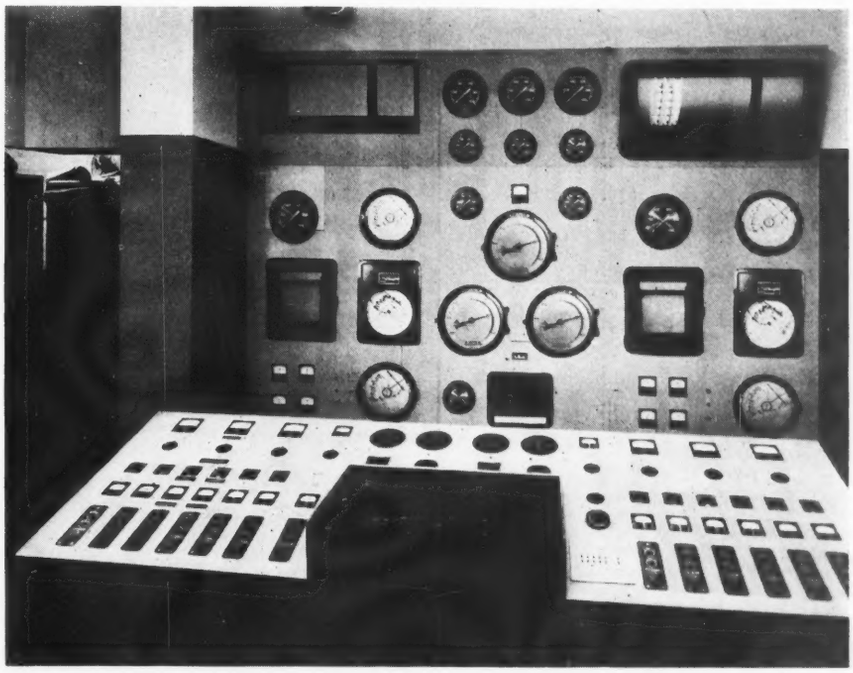


Fig. 3—Photographic enlargements and blueprints represent accurately meter positions and appearance. Operators have a chance to get the "feel" of the board and make suggestions before the real thing comes along

Another benefit realized from constructing the model was the expediting as well as coordinating the numerous opinions and approvals required of a large and complex organization before a project can be put in final form. Once the model has been started, it stands as a strong incentive to all groups who have responsibility for the design, to add their ideas. In this way conflicting ideas are soon smoked out, and with the model crying for completion, a coordinated satisfactory solution is quickly obtained.

Fig. 1—All auxiliary control devices for the car-dispatching system are centered on the starter's panel

Fig. 2—Car operator's panel board with dispatching lights at top, car buttons and operating lever below

Modernized Elevators Give 25% More Service

New control equipment and cars, plus a scheduling system that dispatches the cars according to traffic demands, boost capacity for New York's Singer Building high-rise elevator system

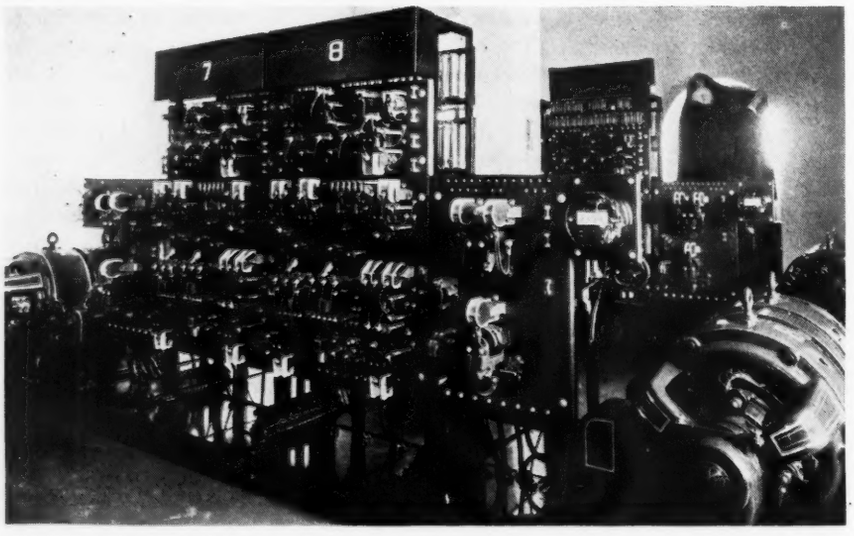


Fig. 3—Controllers and generators for two of the elevator machines

▶ WHEN COMPLETED IN 1908, New York's Singer Bldg was the highest office structure (612 ft) in the world. Though the building was later surpassed by quite a few skyscrapers, its elevator system, consisting of 19 Otis cars, three of which rise 35 stories and one 40 stories into the tower, has continued noteworthy.

In 32 years of service, each of the four high-rise cars piled up a mileage over 294,000, so recently they were modernized with Otis Elevator Co unit-multi-voltage, micro-self-leveling, Peak-Period control with highest-call return. In additions, cars were replaced by modern ones, including slings and safeties. A new starter's control panel and a new car-dispatching system have also been installed.

No changes were made on the gearless-traction machines, one of which is shown in Fig. 4, but a motor-generator was installed for each as part of the control system. Ample space for these machines and the new control system, Figs. 3 and 6, was available in the main tower machine room. The original car speed of 600 fpm has been retained, but the elevator machines have sufficient capacity and the new controllers have been arranged so that speed can be increased to 900 fpm if desirable.

Elevator traffic in a building may be divided into a morning peak, when practically all travel is up; an intermediate period when traffic is about the same in both directions; early noon which gives a down peak and late noon an up peak followed by an intermediate period of normal traffic in both directions; and the day completed with a heavy down-traffic peak followed by night service. These periods require changes in the elevator-operating system to provide the most efficient and economical service.

Elevator Control

Peak-Period control, with which the Singer-Bldg elevators are equipped, meets the changes in traffic automatically, and is put in action by the starter pressing a button. On the starter's panel are four buttons: one each for up dispatching, two-way dispatching, down dispatching and night-service dispatching.

When the button corresponding to up-direction dispatching is pressed, such as during the morning up-peak, each elevator is automatically reversed at the floor where the highest call is registered and returns to the ground floor. Thus every car is returned for reloading as quickly as possible and without any attention from either the starter or car attendant.

Cars are time-dispatched automatically from the lower landing with the interval between their departures made just long enough to permit loading in an orderly manner. Thus, the passengers get away from the ground floor with a minimum of delay and the elevator plant delivers its maximum up capacity.

After the morning peak passes, the starter presses a button corresponding to 2-way traffic and all elevators then operate in a normal manner. With this system of dispatching, cars can pass each other in the hoistways and the elevators are not slowed down to the pace of the slowest car. Cars are automatically dispatched at the ground floor as they become available. A car, therefore, may be shut down regardless of its place in the schedule without interfering with the regular dispatching of other cars, since these are dispatched as they become available, at predetermined intervals at the lower and upper terminals.

Should a car fail to reach the upper terminal by the appointed time, thus producing an unequal distribution of cars, the control proceeds at once to correct this condition. The first up-traveling car to reach a pre-determined zone below the top terminal will immediately respond to the unanswered top-terminal dispatching signal by automatically reversing itself at its highest registered call. Thus, part or all of the previous delay is made up.

If this car has a passenger for the top terminal it must naturally proceed there, and it will respond to the unanswered dispatching signal at that point, unless a second car enters the predetermined zone and reaches its highest registered call before this happens. In the latter case, the second car reverses and assumes the responsibility for the unanswered dispatching signal. Thus, most efficient use is made of the elevators automatically with minimum attention.

When the key switch corresponding to night service is turned, the cars assigned to night-duty service will reverse automatically at the floors where their highest calls are registered. A signal buzzer notifies the elevator attendant of a registered call. He then starts his car, travels in the up direction and automatically stops where the highest call is registered. On the way down all intervening calls are answered.

Peak-Period control thus assures automatic change of elevator operation to meet changes of traffic; permits the removal of any car or cars from the elevator system without interfering with the cars in service; incoming passengers are carried to their floors without delay; and the building is depopulated in a minimum time, with equal service to all floors.

This control is centered in the dispatcher's panel, Fig. 1. Here are the buttons for changing from one form of dispatching to another, a control for changing the period between car departures from terminal landings, switches for cutting cars in and out of the dispatching system, a button that permits the dispatcher to run any car down non-stop and a call-back button for each car. This panel in combination with the car-position indicator, waiting-passenger indicator and the dispatching-signal lights on the panel permits the starter to direct movement of the elevators to obtain maximum service.

With Peak-Period control, car operation is entirely automatic from push-buttons in the car and at the landings, with the exception of car starting. This is accomplished by moving a small lever to the start position, after which

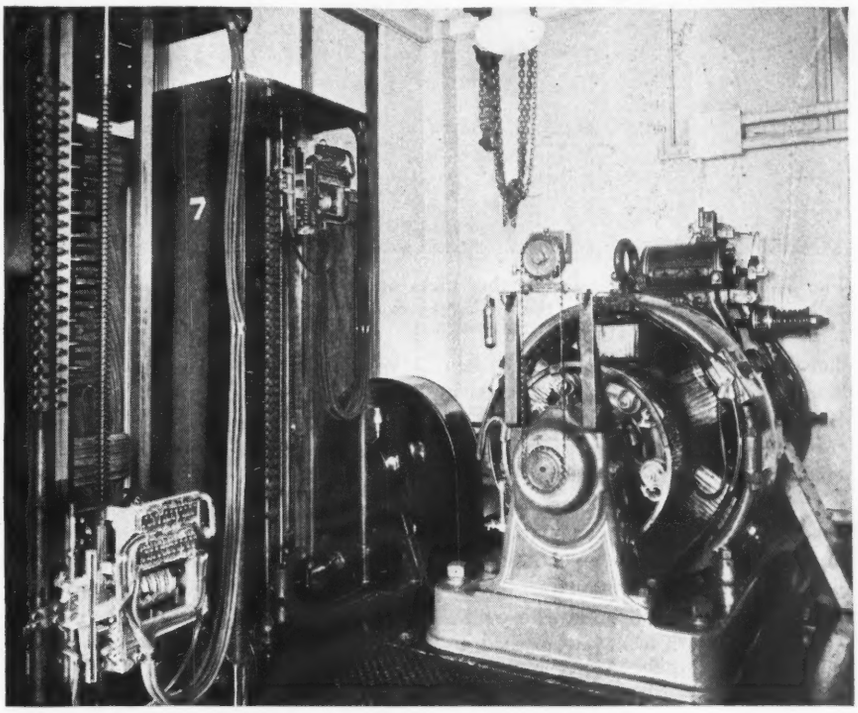


Fig. 4—One of the original direct-traction machines with two of the new floor selectors and an advancer panel in the lower left-hand corner

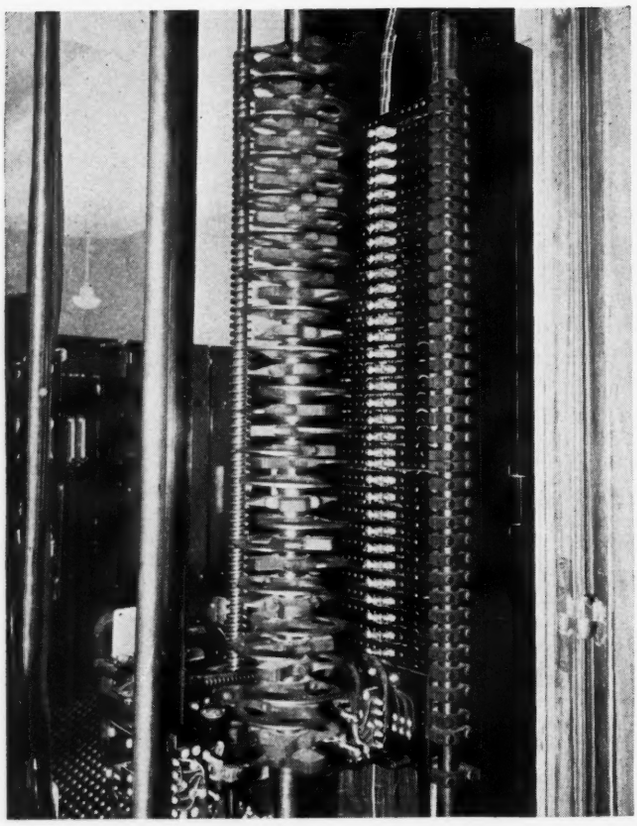


Fig. 5—One of the new selectors that picks up the passenger calls and automatically stops the car at the floors

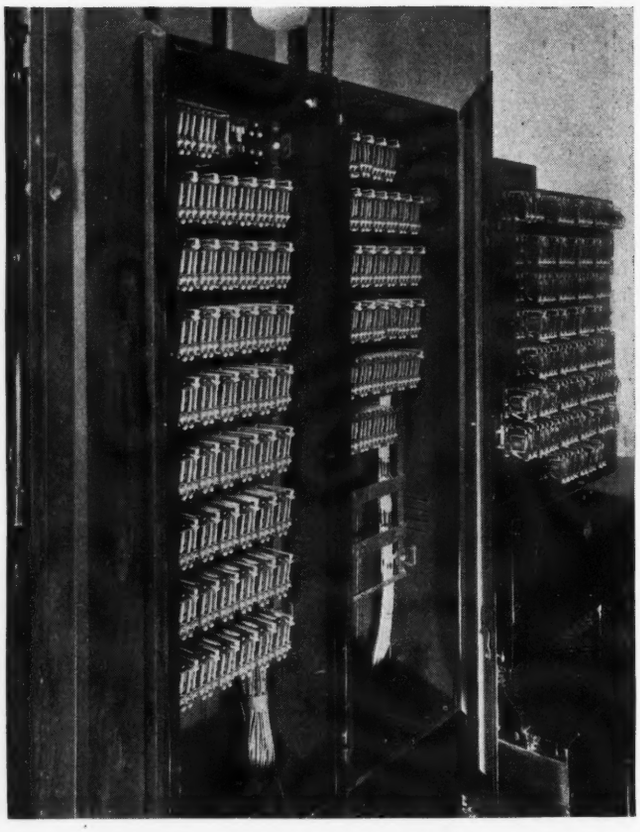


Fig. 6—Floor-stopping relays for the Peak-Period control with highest-call return and dispatcher's controls

hoistway and car gate close and then the car goes to the first floor for which a button has been pressed, stops, and the car and hoistway gates open automatically.

On the operator's panel in each car, Fig. 2, in addition to the start lever, are a bank of pushbuttons, one for each floor served. These buttons are of the individual-reset type, so that if a wrong one is pressed it can be released to the no-call position. Above this bank of buttons are four lights. A red light signals the operator to start the car in the up direction and a green light is the down direction signal. This light operates in combination with the down floor lantern at the top landing. The floor lantern lights first to show the operator that her car is the next to leave. At the scheduled leaving time the green lamp lights and a single-stroke bell sounds.

Car Waiting to Load

When a car is waiting dark at the ground floor for its turn to load, a white light flashes to signal the operator to load, after which the red light flashes and a signal bell sounds the scheduled starting time. A blue light shows the highest up call. When the car is in normal operation, this light remains lighted all the way to the top terminal. If the car is selected to reverse when the highest call is answered, then the blue light goes out at that floor to show the operator that the highest call has been answered and that the car will go down.

Below the bank of floor-call buttons on the car operator's panel are buttons to reverse manually the car at any position in the hoistway, to micro-level the car up or down, to run the car non-stop, emergency stop, and one to permit the car to go to the top landing when operating on a highest-call-return schedule. Under-glass buttons are provided for emergency opening of car and hoistway doors. The fan, car lights and night buzzer are each controlled by a switch.

Floor Selector

Control for these cars has an improved type of selector, Figs. 4 and 5, provided with what is known as an advancer panel. All the mechanically operated contacts that were on top of the old-type selector are on the traveling crosshead of the new design. When the car-starting lever is moved to the start position, the advancer panel immediately moves to the floor position on the selector where the next stop is to be made, provided this stop is within about 50 ft of where the car is standing. The advancer panel closes the circuit for the floor lantern to indicate to waiting passengers the next car that will stop at that floor. After the advancer panel has picked up the floor call no other car can take the signal. Thus, a positive signal is given to waiting passengers of the approaching car, well in advance of its arrival. Closing the doors starts the car and when the selector crosshead catches up with the advancer panel, it slows down and stops the car automatically at the floor without attention of the attendant.

If the next call is more than 50 ft away from where the car is when the call is made, the advancer panel will move a distance on the selector corresponding to about 50 ft in the hoistway, will advance with the floor-selector crosshead until a floor signal is picked up, then will stop and light the floor lanterns. The car is then stopped when the selector crosshead catches up with the advancer panel, as previously explained.

Improvements Made

Installation of the new control equipment has increased the elevator service about 25%, which permits operating the cars on 35-second headway in normal operation. The highest-call return control makes possible utilizing the elevators just where they are needed during rush periods to handle the traffic most efficiently.

Why and How of Blowdown

Lack of care in layout and operation of blowdown systems sets up serious accidents. Harry Spring reviews fundamentals of blowing down for the younger operator and for engineers whose familiarity with this operation may breed carelessness

▶ IN SPITE OF ALL that has appeared in POWER and other publications regarding the danger of mishandling boiler blowdown valves, major accidents still occur; during the past year several took their toll of life and property. Thus, both younger operators and experienced engineers who might be inclined to be a little careless through familiarity can profit from a quick review of blowdown fundamentals. We need to know what a blowdown is, why we blow down, and, above all, how to blow down safely.

What is a Blowdown?

Blowdown operations may be divided: (1) service blowdowns (or blowoffs) and (2) surface blowdowns. For the first, a pipe connection is provided at the lowest practical pressure part of the boiler (Fig. 1). The connection may vary in size from 1 to 2½ in., except that the ASME Code for Power Boilers permits a minimum size of ¾ in. for boilers having not more than 100 sq ft of heating surface. This connection includes one or two valves, as discussed later.

The surface blowdown, located at the average water level and often provided with a skimmer (Fig. 2), removes scum formed by organic matter in the feed. Modern methods of treating feedwater usually prevent this condition, and use of the surface blowdown is no longer common.

Why Blowdown?

Blowing down does three jobs. First, the blowdown rapidly lowers the boiler water level in case it accidentally rises too high. This action reduces the possibility of an accident from slugs of water passing on with the steam flow.

Second, the blowdown permits removal of precipitated sediment or sludge, while the boiler is in service. Otherwise it might be necessary to take units off the line frequently, to wash out sludge accumulations.

Third, and probably most important, blowing down controls the concentration of suspended solids in the boiler. Practically all raw makeup water contains some solids in suspension. These solids tend to remain in the drum as steam is generated and, if nothing were done, the concentration of solids would build up to a point where it would be impossible to make clean steam.

For example, suppose the feedwater averages 100 parts per million of suspended solids, and suppose further that no solids are carried over with steam and that no provision for deconcentration is made. If all the water in the boiler is evaporated and replaced once each hour, the concentration at the end of 24 hrs will be $24 \times 100 = 2400$ ppm, and at the end of 100 days it will be 240,000 ppm. This means that nearly 25% of the boiler contents are sludge, scale, or suspended solids. It isn't hard to see that serious trouble would appear long before the 100 days is over. Blowing down eliminates these difficulties by removing enough of the high-concentration boiler water to reduce the amount of suspended solids in the boiler to a safe limit.

When to Blowdown?

Simple tests of the boiler water give the data needed to set up a practical and economical schedule for blowing down. Remember that removing hot water under pressure means loss of heat units and consequently loss in fuel and in dollars (see POWER data sheet No. 69 for a quick method of figuring blowdown cost). To save money, refrain from blowing down the boiler (except in emergency) until the concentration has attained the predetermined safe limit, and then blow down only enough to prevent the concentration exceeding this limit. The maximum permissible concentration of solids depends on the boiler design, on the nature of the load, and on the importance attached to purity of steam. For many boilers, 1000 ppm represents a reasonable limit.

Although outside the scope of this brief article, mention should be made of continuous blowdown. In this system, a small amount of water is constantly bled from the boiler, the amount

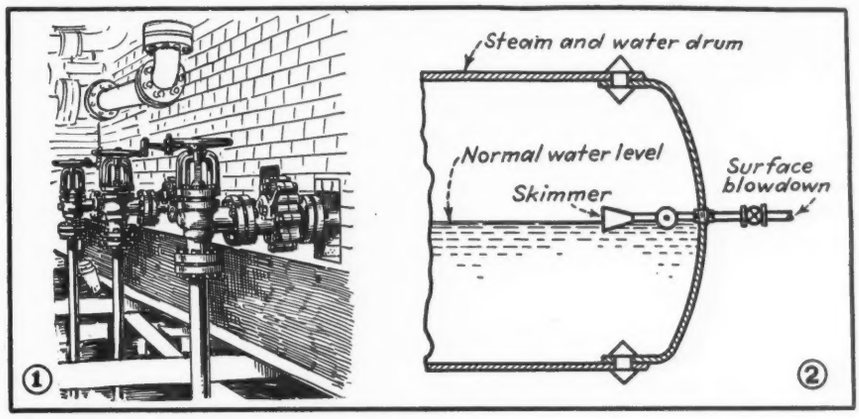


Fig. 1—Tandem blowdown valves at rear of boiler. Fig. 2—A surface blowdown connection, with skimmer

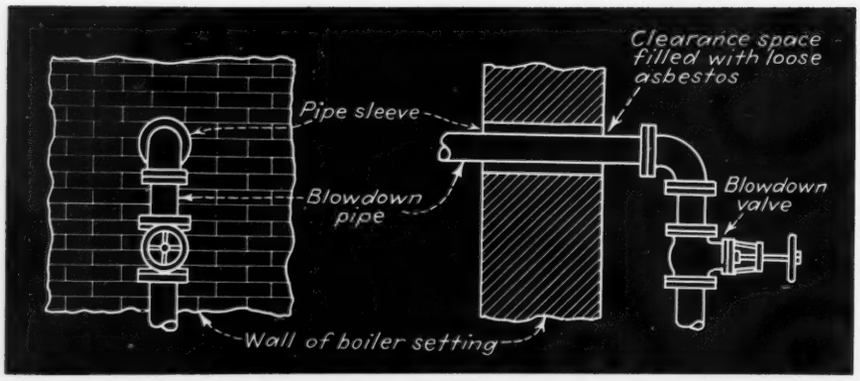


Fig. 3—Clearance sleeves allow for pipe expansion

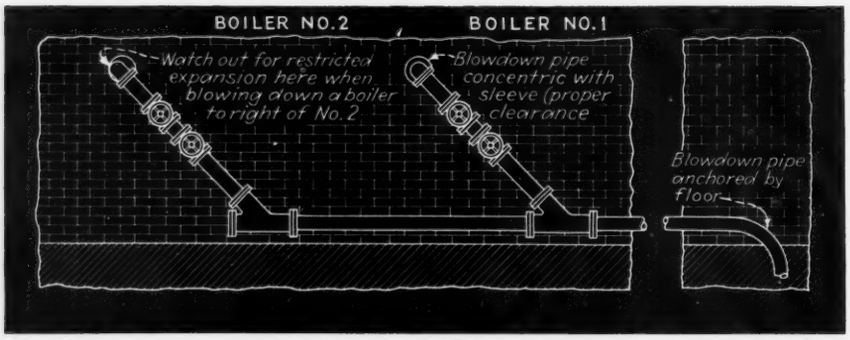

BOILER NO.2
BOILER NO.1
Watch out for restricted expansion here when blowing down a boiler to right of No.2
Blowdown pipe concentric with sleeve (proper clearance
Blowdown pipe anchored by floor

Fig. 4—Expansion in direction perpendicular to clearance sleeves may cause trouble

being regulated to maintain the desired concentration limit. Equipping a system of this kind with heat exchangers or flash tanks salvages most of the Btu's from the blowdown water and all that is lost is a quantity of contaminated water.

What Kind of Valves?

To start with, one common valve that should *not* be used is the globe. While excellent for throttling service with clean fluids, the globe's "S" flow makes it unsatisfactory for water containing solids. The seat forms a dam or pocket in which sediment or scale may lodge and soon block the entire passage.

A gate valve or a cock with its plug held in place by a guard or gland and marked for line of opening will meet blowdown requirements. However, because of the erosive action of solids moving at high velocity and the need for absolutely tight seating, manufacturers have developed many types of "blowdown" valves. A description of the types available and cross-sections showing their construction appeared in POWER's special section "Fluid Highways," December, 1937.

For pressures up to 200 lb per sq in., The ASME Code permits cast-iron blowdown valves constructed according to the American Standards for at least 250 lb. For pressures not in excess of 100 lb, the Code allows 125-lb standard valves as a minimum requirement. For pressures over 200-lb, steel valves must be used.

Code regulations cover blowdown valves and fittings comprehensively and this Code has been adopted in the law of many states. In any case, the Code should be consulted and followed to assure safety.

How Many Blowdown Valves?

The Code specifies that two slow-opening valves or one slow-opening and one quick-opening valve shall be used when the pressure exceeds 100 lb per sq in. The Code defines a slow-opening valve as one that requires at least five full 360-deg turns of the operating mechanism to go from the closed position to full opening. For pressures of 100 lb, or less, one blowdown valve meets requirements, although two are sometimes used.

Blowdown Valve Operation

"Avoid sudden changes in flow velocity!" This is the most important rule in blowing down. Quick opening or closing of a valve controlling boiler water under pressure may set up such a reaction or "hammer" in the piping as to cause rupture of pipe or fittings.

With tandem blowdown valves (Fig. 1), it is customary to mount the quick-opening valve nearest the boiler. This should be opened first, taking care to raise the disk from the seat slowly. Then open the second valve, taking the same care to operate it slowly. In closing the valves, reverse the procedure. Operating this way means that the valve farthest from the boiler controls the flow both in opening and closing. This valve bears the brunt of the wear and tear. On the other hand, the valve nearest the boiler controls minimum flow and a "tight" valve nearest the boiler is assured. Thus, with care, one can repair the outer valve without removing the boiler from service.

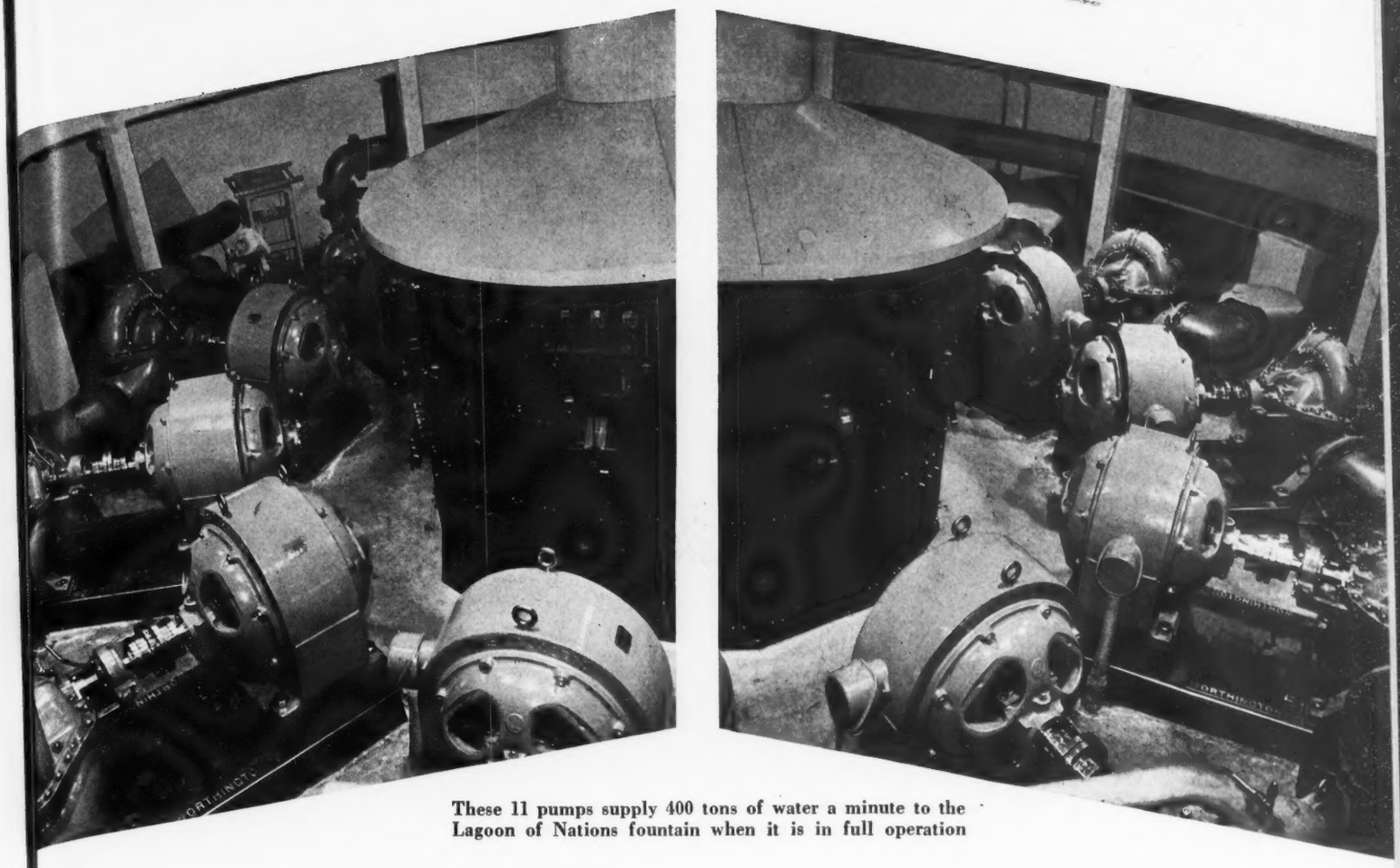
Many operators discover that the slow-opening valve operates much easier when it does not control the flow and are inclined to reverse the procedure outlined. In addition to subjecting to wear a valve that cannot be repaired with the boiler in service, they take the chance of severely stressing the entire system by controlling the flow with the quick-opening valve. This practice may be extremely hazardous.

In addition to handling the valves properly, the operator must know that the boiler water level is high enough to permit blowing down, and someone must be stationed at the valves until they are closed. Too often operators allow something to distract their attention while blowing down and the water drops to a dangerous level with unfortunate results to the boiler.

Watch for Expansion

Most engineers are familiar with the use of a sleeve and clearance where the blowdown pipe passes through a brick wall (Fig. 3). This prevents binding in the brickwork when the pipe expands or contracts. However, many tend to forget expansion perpendicular to the wall opening, which may be troublesome when the end of the blowdown piping is anchored, as is common when it turns downward through the floor. As shown in Fig. 4, expansion in this direction may cause the pipe to bind in the brick wall and produce heavy stresses. Expansion loops or abrupt turns with many fittings are not desirable in blowdown piping. It is best to provide ample clearance for free expansion at each end of the long run of piping.

Pipe tends to expand 0.0000065 in. per in. of length, per deg F rise in temperature. Thus a 30-ft length of blowdown pipe subject to a temperature rise of 80 F to 250 F would tend to expand $30 \times 12 \times (250 - 80) \times 0.0000065 = 0.397$ in., or a little over $\frac{3}{8}$ in. If this expansion is restricted severe stresses will be set up and trouble is bound to follow.



These 11 pumps supply 400 tons of water a minute to the Lagoon of Nations fountain when it is in full operation

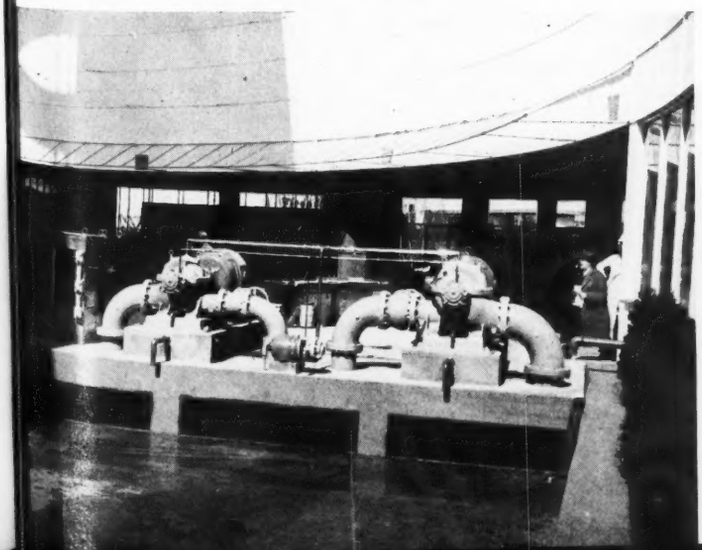
Water Falls on The Fair

▶ WATER AND LIGHT in the hands of engineers have made the New York World's Fair one of the most beautiful spectacles of all time. To supply fountains, cataracts, cascades, jets, and reflecting pools requires at times approximately 250,000 gpm of water. Such a tremendous quantity is possible only because the water is recirculated; the only loss is by evaporation and wind-blown spray.

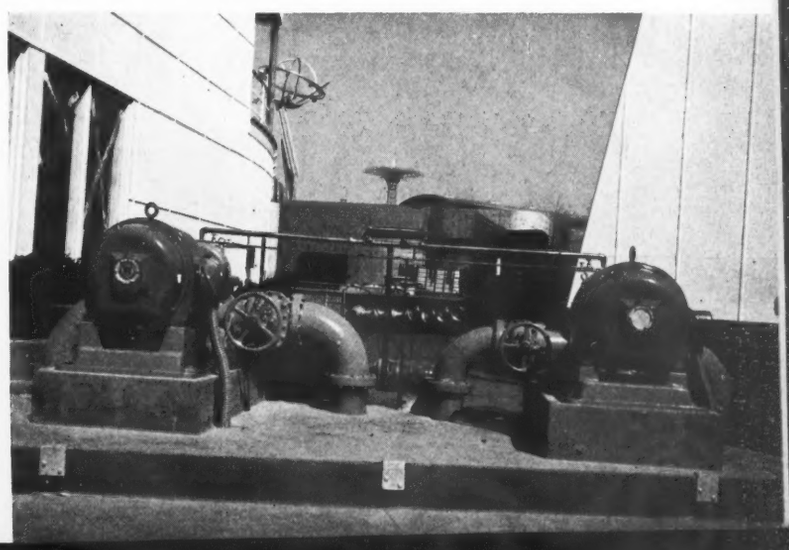
The most breathtaking of all the water exhibits, the Lagoon of Nations fountain, uses 100,000 gpm in full operation. Water is supplied by 11 Worthington pumps driven by Westinghouse squirrel-cage motors equipped with General Electric controls. The units are arranged like the spokes of a wheel, with the starting equipment forming the hub in the center of a circular glass-inclosed room. The pumps are below water level and self-priming.

An addition this year is the 120-ft high singing-tower water fall, part of the Westinghouse exhibit. Six tons of water at one time will tumble down over 15 cascades lighted by 24,400 candlepower of white light and 24 1540-watt under-water lights. Water will be supplied by four 75-hp, motor-driven pumps with a combined capacity of 12,500 gpm.

Two of four 3,250-gpm centrifugal pumps that supply water to the 120-ft singing tower waterfall



Each of the singing-tower pumps is driven by a 75-hp squirrel-cage induction motor with its starter outdoors



Sunset—Golden Gate

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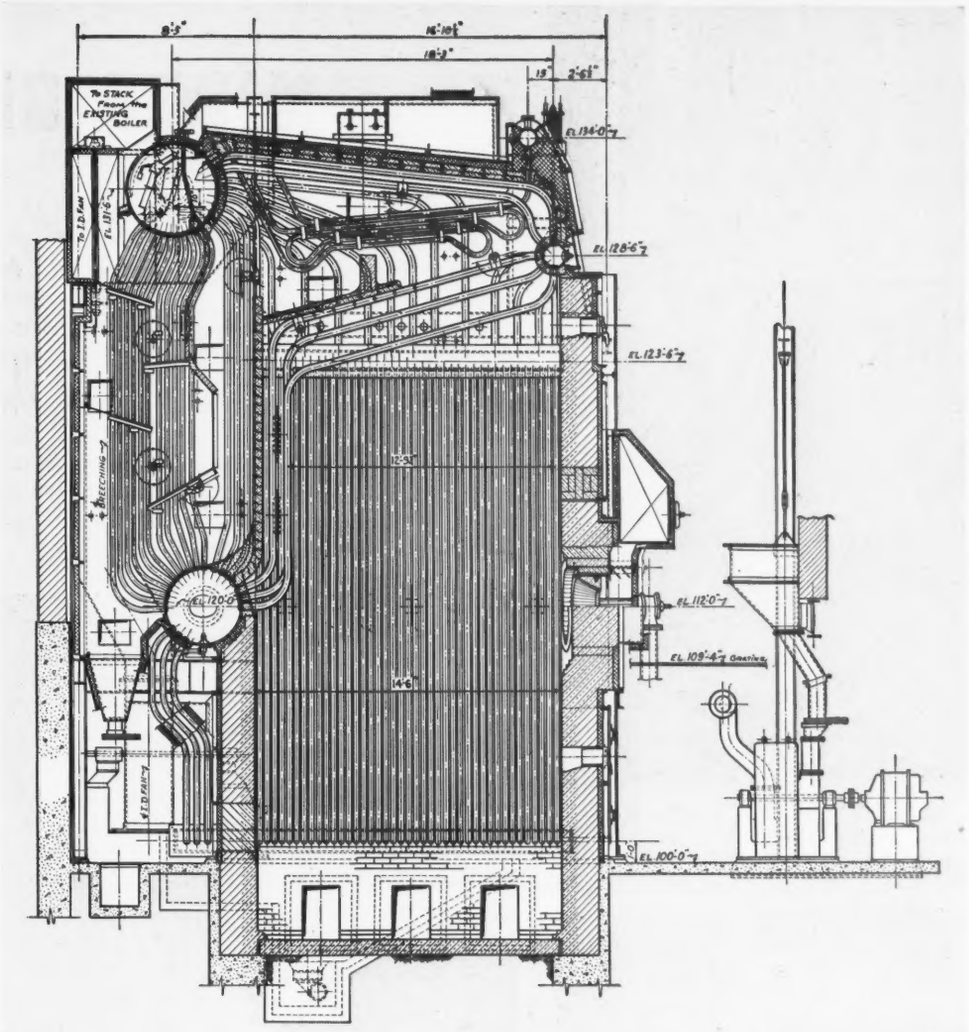
Actual Test Efficiency at 33,000 lbs./hr. 87.3%

Unit equipped with Riley Boiler, Superheater, Water Walls, Air Heater fired with Riley Atrita Unit Pulverizer.



. . . and an Engineer's—

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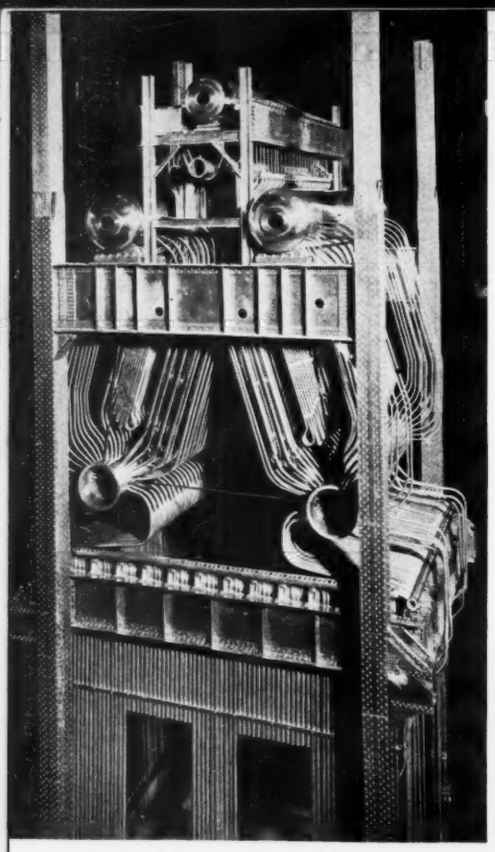
before purchasing Boiler or Fuel Burning Equipment

MICRO GIANT

▶ LATE IN APRIL Editor Phil Swain visited the cellar workshop of E C Keithley in Detroit to see this all-aluminum scale model of the latest high-pressure boiler in the power house at the Ford Motor Co's Rouge Plant. With the help of four students from Detroit University, Mr Keithley was completing his masterpiece for Combustion Engineering's exhibit at the New York World's Fair. After the fair it will be presented to Mr Ford.

Mr Keithley, Superheater Co and Combustion Engineering Co field man for the past 20 years after 17 years of mechanical work in the Navy, has equipped his home workshop with lathe, drill press, milling machine, sheet-metal bender, tube formers and benders, metal saw and many small tools.

The real No. 7 Rouge boiler, of which this is an exact replica, $\frac{1}{16}$ scale, will generate 900,000 lb of steam per hr at 1400 lb, 925 F.



This model contains 1¾ miles of aluminum tubing, precise in section and contour, with each tube rolled in

Model maker Keithley drills a flange bolt hole. Such parts are aluminum castings, machined and polished

Just one of the 288 superheater elements, all alike (checked to template). Spacers are welded in

Keithley's Detroit University student assistants have a large order with 2346 tubes and 14,000 rivets

All around the cellar the boys work —cutting, bending, matching, fitting to exact dimensions

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Eavenson & Levering

MAKES MODERNIZATION PAY AS IT GOES

When the boss is shown the economy and better performance of each change before being asked to shell out money for the next modernization step, the result is an up-to-date power plant in first-class operating order

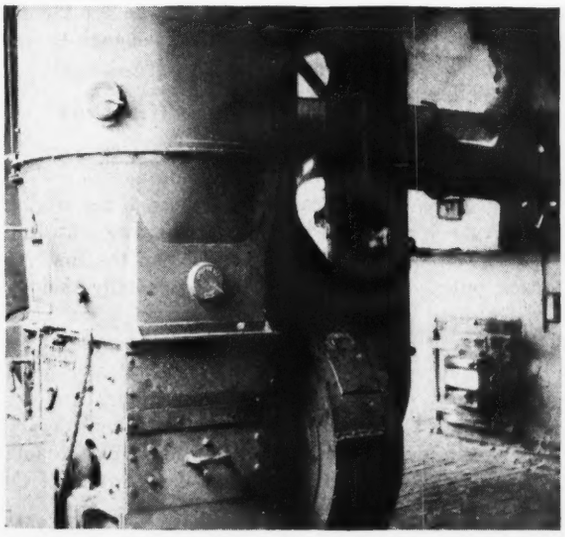
By W A LOFFT
Chief Engineer

MODERNIZATION of the power plant at Eavenson & Levering Co's wool-scouring and carbonizing plant, Camden, N. J., has been a step-by-step process, with each improvement designed to pay for itself as quickly as possible. In this way, the management has been able to see the economy and better performance of each change before being asked to grant money for the next modernization step. The result is that today the power plant is up to date and in first-class operating order.

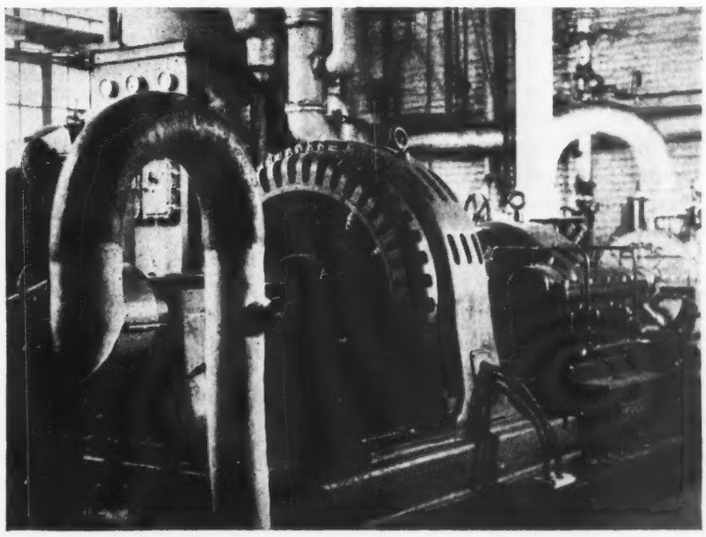
In 1934 the boiler plant consisted of two 4000-sq-ft, two 17,500-sq-ft and one 1500-sq-ft units, all stoker fired. A single 750-kw turbine operated at 200 lb throttle and extracted at 7 lb for process and heating. The 750-kw, 440-volt, 2-phase generator had enough capacity to carry factory load.

That year, modernization started rolling when a pulverizer was put in for one of the 4000-sq-ft boilers. At the same time, this unit was modified to make more efficient use of pulverized fuel, by installating a single side waterwall of 300 sq ft heating surface. Although we realized that we could probably get better results by raising the boiler, this was put off as the boiler was due for replacement in a few years.

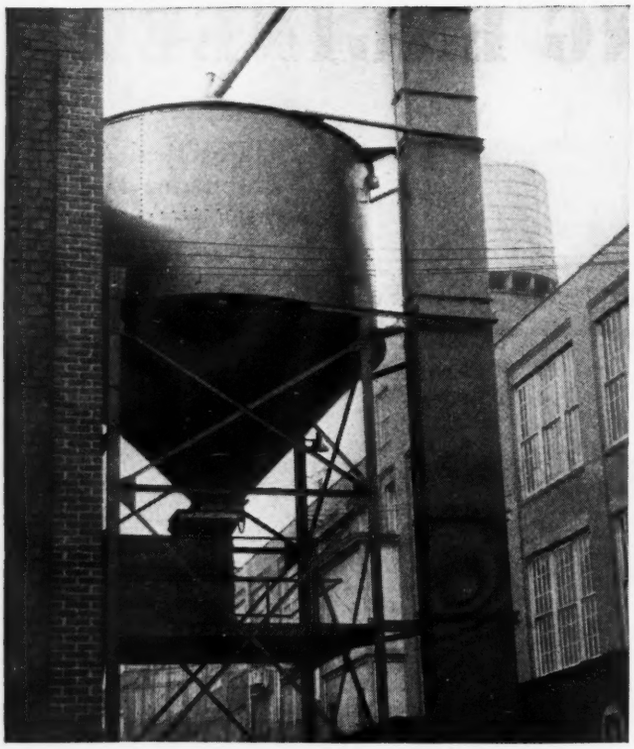
However, plant performance and fuel saving with pulverized coal proved so gratifying that we modified the other 4000-sq-ft boiler in the same way, equipping it with a similar 2500-lb-per hr pulverizer. With pulverized fuel, efficiency of these two units averaged 75%, compared to 63% with stoker



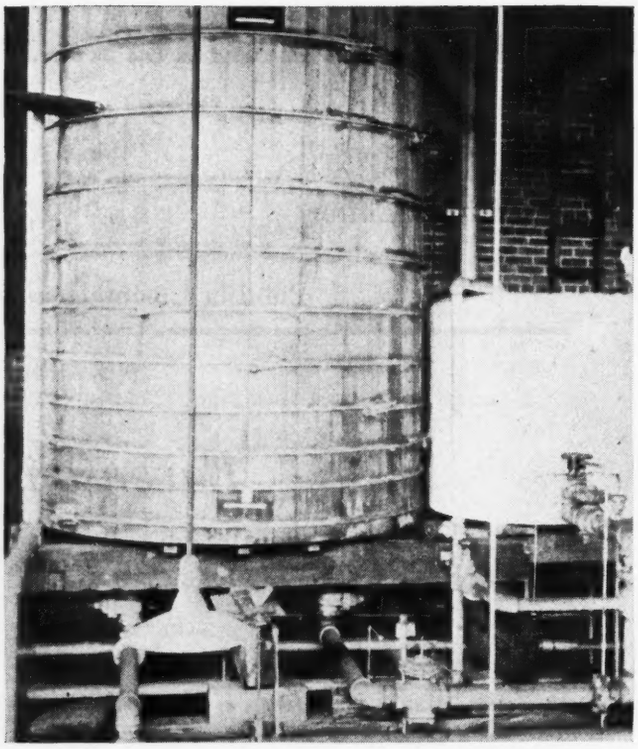
2500-lb-per-hr pulverizer on boiler used for standby



Backpressure turbine serves as a reducing valve



Part of the modernization program is this 60-ton bunker and elevator installed to facilitate coal handling



Brine-reclaiming tank saves four 200-lb bags of salt per day lost in regeneration of zeolite used to treat boiler feed

firing. Also, we could operate these boilers continuously at 200% rating with no trouble at all.

Cost of pulverizing equipment and boiler changes was $22,000. Within three years after installation, the equipment saved $35,000, more than two-thirds due to fuel saving alone. The rest came from lowered maintenance and operating costs.

New Control Equipment

Also in 1934, control equipment was improved so that constant steam pressure could be maintained in spite of wide load variations. We put in a damper in the boiler breeching, designed to maintain automatically constant draft over the fire. A single regulator, actuated by pressure in the main steam header, adjusts rate of fuel supply to each boiler. A feeder arm in the pulverizer regulates amount of coal being fed in proportion to the amount of air, nearly all of which enters with the pulverized coal. The immediate response of the damper in the common fuel and air line eliminates any time lag between action of the pressure regulator and the corresponding change in fuel supply.

The next improvement was in the water-treating equipment. The entire factory uses about 400,000 gallons of water daily, obtained from three deep-wells. About 53,000 gal. daily are required for boiler makeup because much process steam is lost in use. Deep-well water, varying in hardness from 6 to 9 grains per gal., is treated by a battery of four zeolite tanks, each with a capacity between regenerations of about 75,000 gal.

We discovered that the brine solution used for regeneration and then wasted, still retained a salt concentration of 2 to 3 deg Baumé, so we put in a brine-reclaiming tank to save this salt. Thus, the brine, after passing through a zeolite tank, is now pumped to a reclaiming tank. When the next zeolite tank is to be regenerated, the reclaimed brine is first passed through before using concentrated brine. The latter is then reclaimed and held ready for the next regeneration. This reclaiming equipment saves four 200-lb bags of salt per day.

To facilitate coal handling, an outdoor 60-ton metal bunker and enclosed elevator was installed to deliver coal directly from car to pulverizers. Automatic scales weigh and record the amount of coal delivered to each pulverizer in the boiler room. This equipment, described in POWER, January, 1940, cost $10,000 and will pay for itself in two and a half years. The accurate operating tests made possible by the equipment have permitted the plant to use a grade of coal averaging 20 cents less per ton, with no loss in operating efficiency or physical condition of the boilers.

Our first turbine-room improvement was a small turbine driving a 200-kw generator. This unit is used as a back-pressure machine to supply 100-lb steam to the process line. Formerly, 200-lb steam from the boilers passed through reducing valves to satisfy the 100-lb process demand. Now, we use this pressure drop in the small turbine. with a reducing valve to help out when demand for 100-lb steam exceeds capacity of the machine.

Although water rate of the turbine is around 150 lb of steam per hr per kw, the electric energy we get is velvet. This proves useful in carrying short-time peak loads too large for the big generator and not large enough to warrant using utility service.

Recirculating Air Duct

A second 750-kw turbine-generator was installed two years ago to provide insurance against failure of the original 750-kw machine. Also, we put in a recirculating air duct on the first machine. This gives us a totally enclosed ventilating system in which the air is cooled by water pipes. Because of this enclosed system, the generator windings seldom need cleaning, and the machine can be operated at considerable overload without overheating. An automatic alarm warns the operator if the machine overheats.

There has been gradual revamping of the entire electric power control and

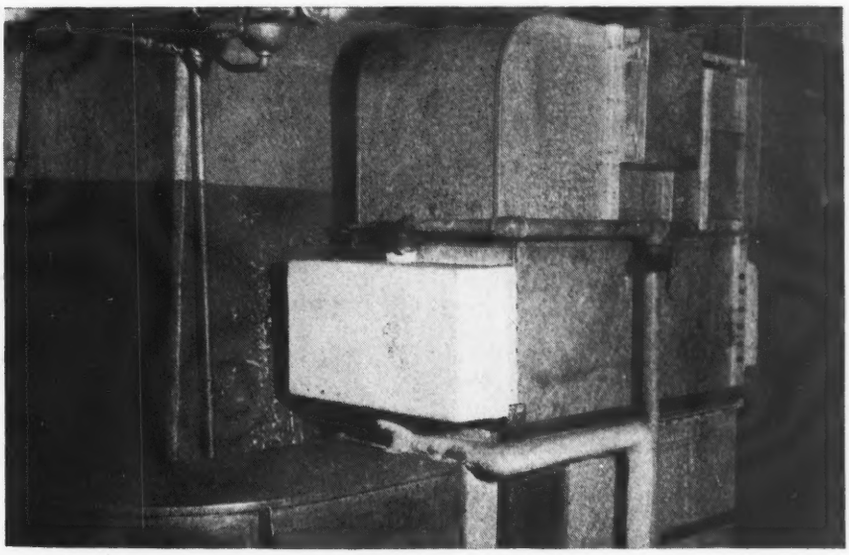
distribution system. Size of the bus structure has been increased and new oil circuit breakers have replaced older ones, to avoid possibility of breakdown due to high loads. The original connection with utility supply, for standby and emergency, was changed to permit increased flexibility and greater ease in keeping the 15-minute demand at a minimum.

Circuit Breakers

We took out the old 200-kva oil breaker connecting the plant with the utility lines and put in a 800-kva breaker. Three double-throw switches permit any of the three factory departments to be connected with utility power. Normally, outside power is used only when the power plant is shut down. A load limit relay on the utility company's primary supply trips the breaker when demand reaches a predetermined value. In event of partially crippled steam supply or other emergency, any of the three double-throw switches may be thrown to cut in the outside power source.

The last power-plant improvement is the long-anticipated replacement of old boilers. We now have two new units, one 6000-sq-ft and the other 4000-sq-ft. These are 3-drum, bent-tube units, with three waterwalls and superheaters. The 4000-sq-ft boiler has one of the old pulverizers; a new 4000-lb-per hr pulverizer was installed on the larger boiler.

Steam is generated at 210 lb, 100 deg superheat. Feedwater is supplied at 212 F. The new boilers are showing efficiencies up to 80% during normal operation and are, therefore, giving marked fuel savings over the old units. A new boiler-room instrument board contains a pressure indicator, steam flowmeter, temperature and CO_2 recorder, and a draft indicator. Although one of the old boilers still stands by for emergencies, we plan a new unit soon to take over this job.



Ventilating duct recirculates and cools air for 750-kw generator—an instance of planned spare-time work. Automatic alarm warns of overheating

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Welding Cuts Compressor-Repair Cost

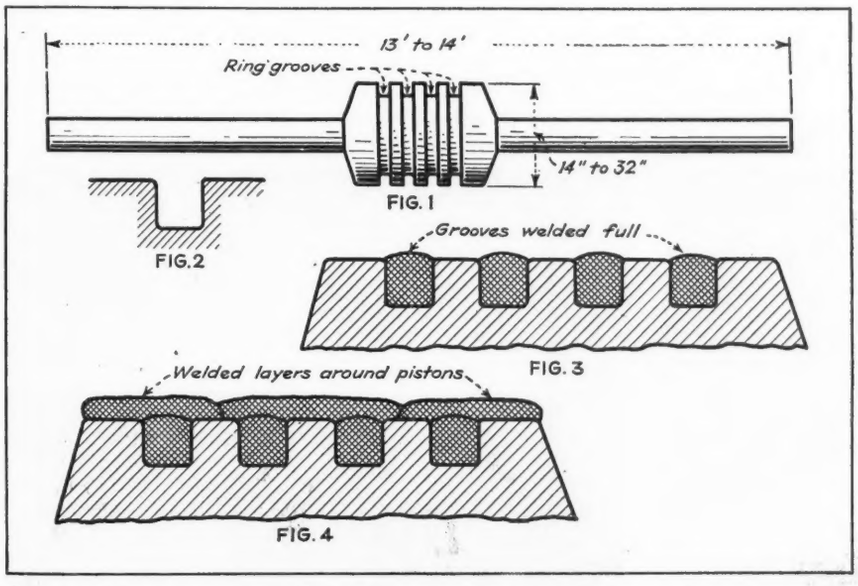


Fig. 1—Dimensions of repaired pistons. Fig. 2—Corners of ring grooves are rounded before welding. Fig. 3—Piston ring grooves are first welded full. Fig. 4—Then, one or two bronze layers are deposited around piston surface

By S W HINES
The Linde Air Products Co
Charleston, W. Va.

KEEPING DOWN REPAIR COSTS, maintaining equipment in condition for highest operating efficiency and having machines ready for service when required are major problems for an operating engineer. The manner in which a prominent West Virginia utility company handles equipment repairs in its machine shop presents an interesting angle on low-cost maintenance.

This company operates many gas-engine driven, natural-gas compressing stations and standardizes on bronze welding for reclaiming worn power and compressor pistons. To date, approximately 100 pistons, ranging in diameter from 13½ in. to 32½ in., have been resurfaced.

The power and gas-compressor cylin-

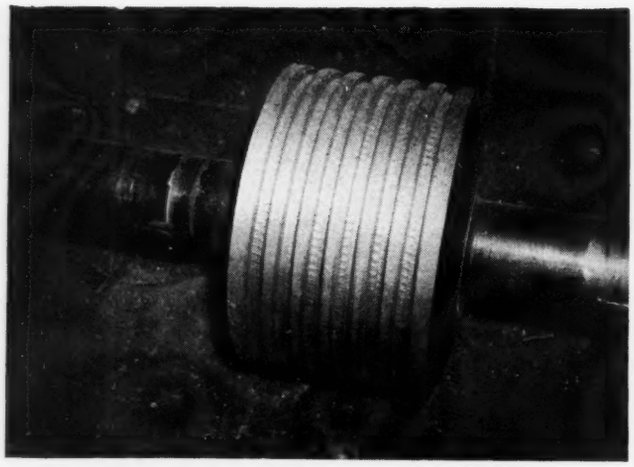


Fig. 5—Piston rough turned for bronze welding

Fig. 6—Piston being bronze welded

ders and pistons wear out-of-round and seriously reduce efficiency. This requires reboring the cylinders, which, of course, means using oversize pistons. Formerly, old pistons were replaced by new cast-iron ones. Now, they are rebuilt with bronze at one-half the cost of new pistons.

First Step

The first step in reconditioning these pistons is to rough-turn surfaces and ring grooves, Fig. 5. This is done so that corners of the grooves can be rounded to about a ½-in. radius, Fig. 2, to prevent burning and cold laps when the bronze is deposited.

Before welding, each piston is preheated with a natural-gas burner. During the preheating operation the piston is supported so that it is directly over the burner, which is in a pit in the welding-shop floor. Before preheating, the repair crew builds a temporary firebrick furnace around the piston, leaving space at the top for the welding operation.

A rope wound around the piston rod and connected to a chain fall rotates the piston while it is being reconditioned. Preheating is carried on, from 1 to 1½ hours, or until the piston becomes cherry-red.

Piston-ring grooves are first filled with bronze, Fig. 3. Metal is deposited at a point about 45 deg above horizontal center line, Fig. 6. This is a convenient point to weld, as the molten metal then does not flow too far ahead of the point of deposit and, therefore, does not tend to trap gases from the cast-iron.

Depositing Metal

After piston-ring grooves are welded full, a layer of metal about 6 in. wide is deposited around each end of the piston and then the space between is filled, Figs. 4 and 7. Generally, one layer of deposited metal over the piston surface provides enough metal for machining to correct size. On badly worn pistons, sometimes two layers are required.

During welding, each piston is kept at about 1400 F. Afterwards, the piston is allowed to cool in air, then placed in a lathe and machined to desired diameter. Finally, ring grooves are cut.

To recondition a 14-in. compressor piston requires 90 to 100 lb of bronze welding rod, 12 to 14 hours of welding time, and 6 hours for the machine work. A 24-in. power piston practically doubles time and materials. A 29-in. piston required 356 lb of bronze rod and 38 hours of welding time.

Using Metal Spray

Worn rods are also rebuilt and machined to original size by the metallizing process. In this case, rods are first rough grooved and knurled to obtain a good mechanical bond. Then, carbon steel of desired hardness in the form of wire is sprayed on the rods until the diameter has been increased about ⅛ in. Finally, they are turned and polished to the original diameter. Piston rods reclaimed by this method are giving satisfactory performance, according to service records.

In addition to the pistons and rods reclaimed by welding and metal spraying, a large number of other engine and compressor parts, as well as pumps and gate valves, are being repaired by the same methods.

Fig. 7—Piston completely welded

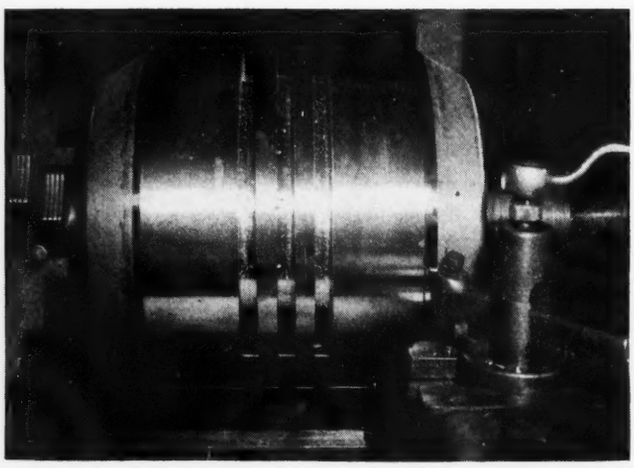


Fig. 8—Piston turned to size and grooved

FORCED CIRCULATION STOPS CORROSION

UP IN MASSACHUSETTS six old boilers are now taking modern medicine—and liking it. The trouble was internal corrosion. The cure, very effective in this case, is forced circulation.

The three vertical firetube boilers pictured are in Station No. 1, Chestnut Hill Pumping Station, Boston Metropolitan District Water Supply Commission. Three similar boilers are in adjacent Station 2. All developed the same trouble, were cured in the same way, so let's see what happened in Station 1 (with the help of Charles P Stuart, Supt of Pumping Stations, who supplied the following information).

Each boiler is a straight-shell unit, with 3028 sq ft total heating surface, 2238 sq ft water heating surface, and 42.3 sq ft grate area. The round firebox is 7 ft 3⅞ in. across and 8 ft 6¾ in. high outside. The boiler shell has an outside diameter of 8 ft 2⅛ in. and is 24 ft 1 in. long. These are old boilers, two (Dillon) installed in 1921, and one (Coatesville) in 1923. Operating steam pressure is 185 lb.

Corrosion Trouble

Corrosion trouble started when these boilers were shifted from coal to oil in 1933, by installing two burners in each boiler. To prevent possible damage from flame impingement on the inside of the water leg, the inside plate was shielded with brick tiling to a height of about 6 ft.

After a year's service with oil, grooving in the water leg became noticeable. The obvious cause was poor circulation, made evident also by the very sluggish pickup of temperature inside the water leg when starting the boiler from cold.

Since forced circulation was the obvious remedy, each boiler was equipped with a centrifugal pump rated at 50 gpm when supplied with boiler water at 185 lb and 382 F and operating against a total dynamic head of 25 lb. Each pump is direct driven through a flexible coupling by a single-stage steam turbine running 1800 rpm normal and 2500 rpm maximum. While the turbine is designed for a maximum working pressure of 225 lb and 475 F, it is large enough to carry full load with 100-lb steam at the throttle. In operation, the steam pressure is reduced by throttling to the turbine as required; a governor keeps overspeed within 15% above normal.

The pumps have stainless-steel shafts, shaft sleeves and wearing rings. The pressure differential through the water leg varies from 0 to 10 lb per sq in. The pump casing of cast steel is designed for a working pressure of 250 lb. Water valves are Monel. Incidentally, this forced circulation system is convenient for feeding water-treating chemicals.

A duplex gage is connected to register pump-suction pressure with one hand and delivery pressure with the other. The differential is an indirect measure of the rate of flow.

The pump takes water from a point about 12 in. below normal working level in the boiler and discharges it in the water leg, on the opposite side of the shell, about 12 in. above the mud drum. To insure circulation, the discharge pipe inside the water leg is plugged at the end, forcing the water to shoot circumferentially through a tapered slot in the side of the pipe. To equalize temperatures and avoid smoke during rapid heating, this water circulation is turned on before burners are started.

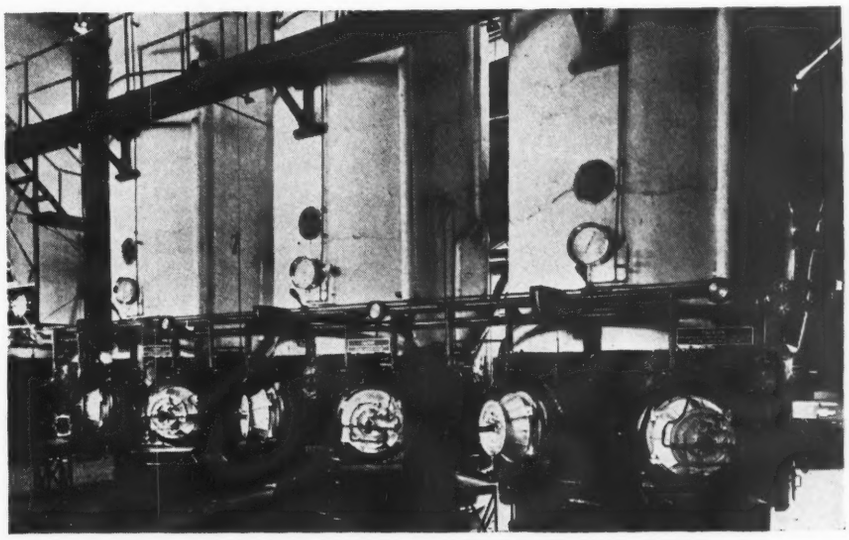


Fig. 1—Fronts of vertical boilers equipped for oil firing

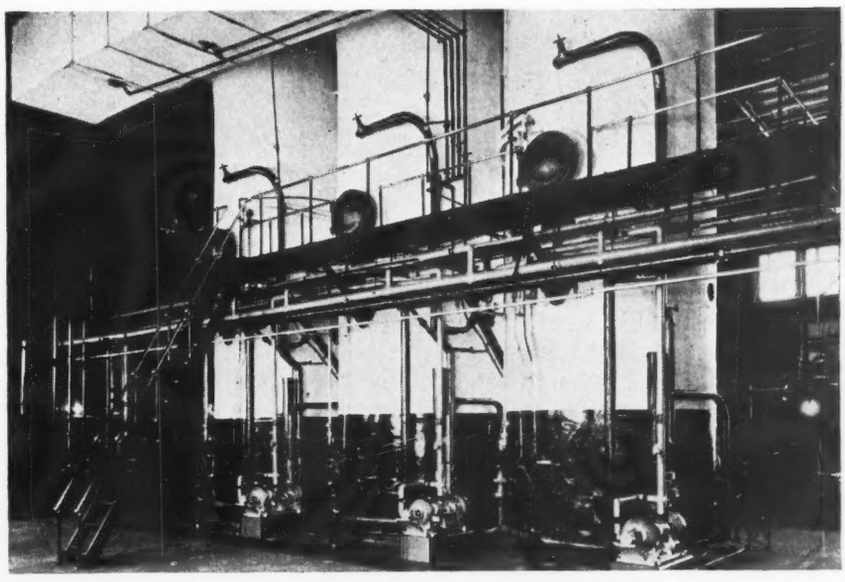
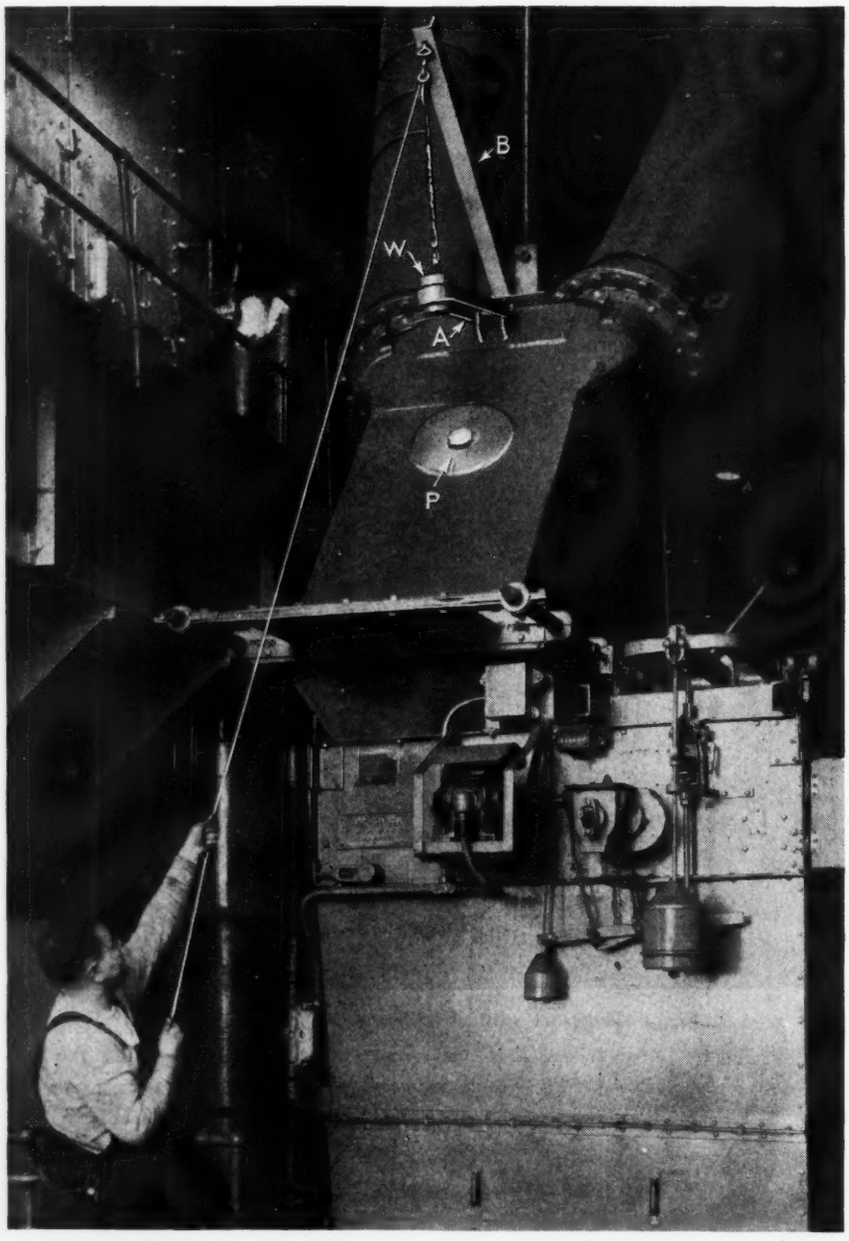


Fig. 2—A pump behind each boiler to recirculate water stopped plate grooving

PRACTICAL AIDS TO OPERATION



Hammer Loosens Coal in Chute

ROPE-OPERATED CHUTE HAMMERS, like that shown, save much climbing at Charles R Huntley Station No. 1 of Buffalo-Niagara Electric Corp. The coal fed to pulverizing mills in this plant ranges up to 1¼ in., but averages ⅜ in. or less. When damp, it is likely to hang up in the feeding chutes from overhead bunkers.

Formerly the operator had to climb up on the scale housing and swing a sledge to loosen the jam. Now every mill-feeding chute in the plant is equipped as shown. The 20-lb weight, *W*, is clamped in one end of a guide arm *A*, attached to the chute, and is lifted by a rope through a pulley supported from the end of a short angle-iron boom *B*. When the weight is lifted by the operator pulling on the rope and released, it strikes the chute a powerful blow. A plate *P* prevents the weight from damaging the chute. This is more than a labor-saving device. It rates also as a safety kink.—FIELD EDITOR.

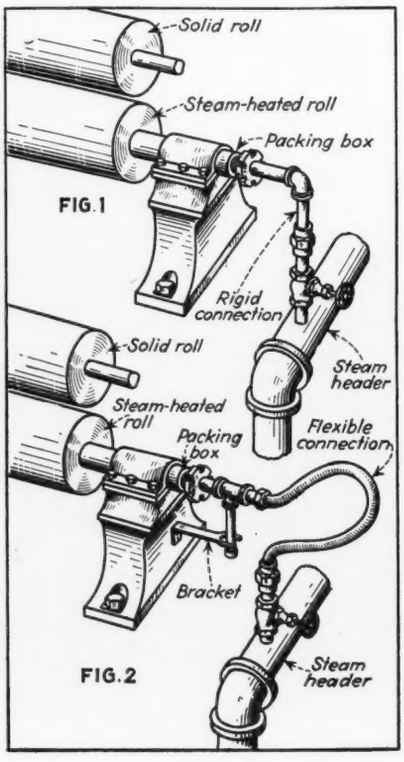
Flexible Hose Cures Packing Troubles

WE WERE BOTHERED with condensate leakage from the steam-heated drying rolls of a board-lining machine. Fig. 1 shows how the steam connections were made from the steam main into the rolls. Because no provisions were made for expansion and contraction of the connections, it was impossible to keep the packing tight in the connections to the roll shafts. To correct this difficulty I used flexible hose for the connections, see Fig. 2.

To prevent the pipe connections that go into the shaft packing boxes turning with the rollers, I used a T between the hose and these connections. In the side connection of the T, I put a capped nipple 6 in. long and fastened a forked bracket onto the bearing so that the fork held the nipple vertical. This left the whole connection free to move vertically and corrected the trouble.

The cost of material to make 14 connections was less than $10.00. They have now been in operation over a year, and the rotating connections have remained tight, without addition of new packing.

Englewood, N. J. R BOETTINGER

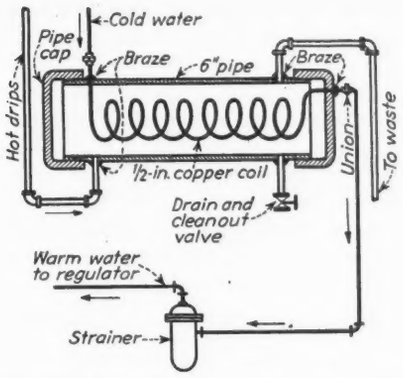


Warm Water Improves Regulator Operation

OUR HYDRAULICALLY OPERATED REGULATORS were originally very sluggish, in spite of their adequate size and the fact that their cylinders were kept continuously lubricated with a special soap preparation. Then, too, during summer months the exterior surfaces of the power cylinders sweated badly because of the low temperature of the pressure water.

To improve plant appearance we decided to install a homemade heater on the pressure-water line, shown in the figure. Heating is done with previously wasted drips, which increase the pressure-water temperature well above the point at which moisture condenses on the exposed surfaces of the regulator cylinders.

After placing the heater in operation, not only was condensation of moisture from the surrounding air eliminated, but much to our surprise sluggish operation of the regulator became a thing of the past. The latter was no doubt due



to warming the lubricant film between the plungers and inside surfaces of the cylinders.

Bethesda, Md. S H COLEMAN

Plugs Turbine Nozzle to Improve Efficiency

IN OUR PLANT we have a centrifugal pump driven at 1900 rpm by a 60-hp steam turbine operating on 130-lb steam. A steam flowmeter on the line to this turbine recorded 72,800 lb daily steam consumption. A pressure gage attached to the turbine side of the governor showed a pressure of 43 lb when the turbine throttle and the pump suction and discharge valves were wide open, indicating that the turbine was not operating near its rated capacity.

This turbine did not have hand-operated valves for closing some of the nozzles to reduce the pressure drop across the governor valve, so we removed the nozzle ring, then tapped and plugged one of the nozzles with a pipe plug. This change increased the steam pressure on the turbine side of the governor to 62 lb and decreased the daily steam consumption to 63,800 lb, and saving of 9000 lb.

On turbines, the value of hand-operated nozzle valves can be more readily realized if a pressure gage is connected to the low-pressure side of the governor valve. This makes it possible for the operator to close the proper number of nozzles to maintain constant speed with minimum pressure drop through the governor valve and thus operate at a higher efficiency.

Buffalo, N. Y. R E FONTAINE

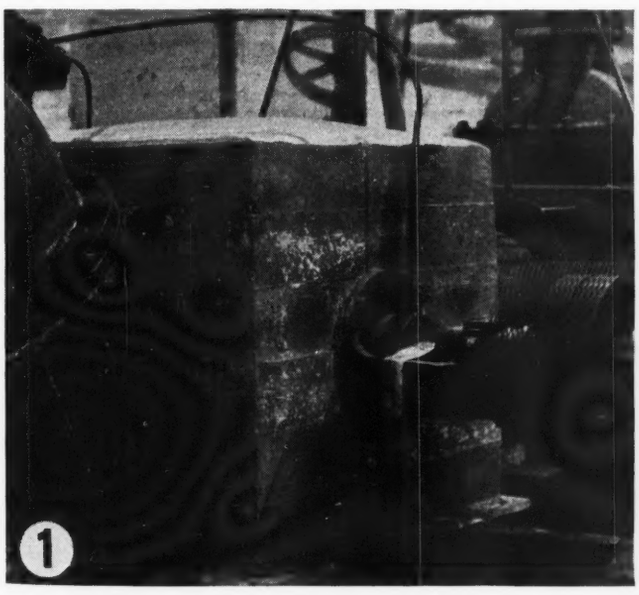
Concrete Casing Keeps Pump Going

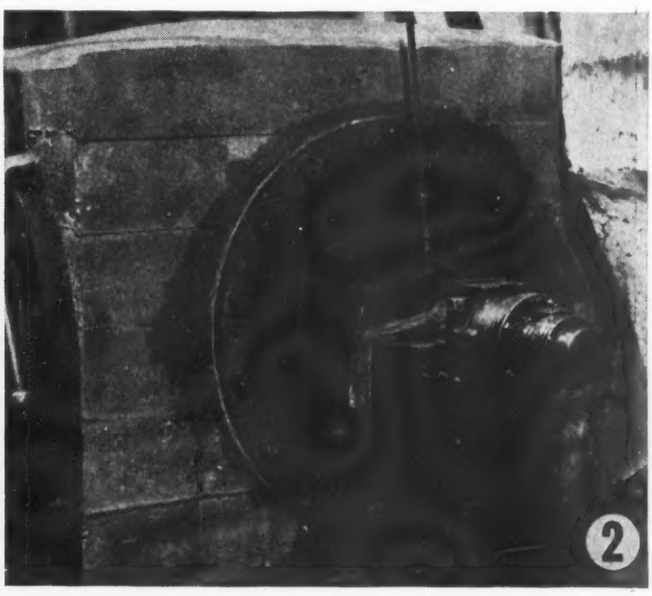
THE CAST-IRON CASING on one of our circulating-water pumps fractured. The crack was a bad one, extending more than half way round the casing on the pressure side of the pump. In addition to permitting water to escape, the crack seriously weakened the flange that supports the outboard bearing for the impeller shaft.

When the pump was dismantled, we found that a large section of the pressure side of the pump casing was of mere paper thickness. This was partly due to corrosion, and also because sufficient attention had not been given to centering the core accurately when making the casting.

As no spare was available, and the plant was operating at full capacity, we set about making a temporary repair. To support the flange, stiffening angles were welded between it and other sound parts of the casing. The contraction of these angles served to tighten the crack, but sealing it by welding was out of the question because of the rotten state of the metal. To seal the crack and support the metal, and, in fact, take its place should it collapse, the entire pump was cast in concrete (see photos).

A form was erected, leaving the necessary dismantling flanges open (the pump is dismantled axially), and reinforcing bars inserted. The concrete was mixed with small granite chippings, sharp sand, and quick-setting cement in the proportions 4:2:1 by volume, and made fairly sloppy. We





washed the pump casing thoroughly free from oil and dirt, then poured the concrete and rammed it into the form. We let the job stand overnight and the following morning put the unit back into service again. Since then the pump has operated satisfactorily.

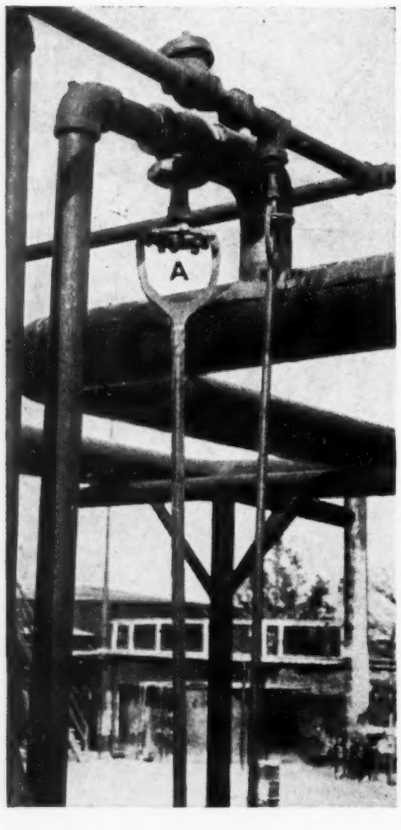
Newcastle-on-Tyne, England T D OSWALD

Stems of High Valves Made Easy to Reach

VALVES in outside overhead steam lines often require extensions on their stems if they are to be operated by attendants on the ground. In our plant we made sturdy handles for this purpose as shown at *A* in the photo. We cut yokes from steel plate, notched to fit over the valve wheel, see diagram. These notches were made sufficiently deep to prevent the yoke from accidently slipping on the valve wheel. In some of the installations we tightened the inside part of the notch onto the wheel so that the yoke could not be removed easily by someone who might wish to use it for another purpose.

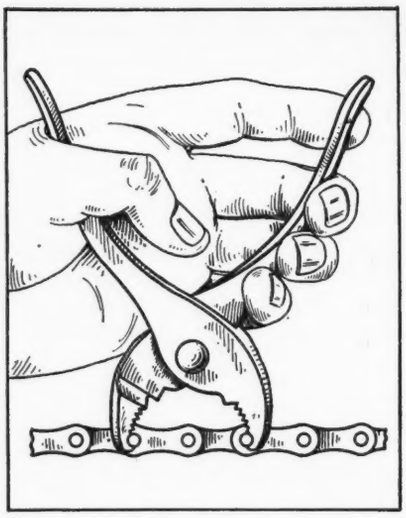
We welded each steel yoke to a ¾-in. or a 1-in. pipe extension, long enough to extend down to a convenient operating height and there fitted on a hand wheel or a simple T-head for operating the valve. We made the latter by welding on a cross piece of pipe long enough to give the desired leverage to operate the valve.

Kilgore, Texas CHARLES C LYNDE



Chain-Linking Pliers

MANY AN ENGINEER has had to hold two ends of a roller chain together and at the same time tried to insert a coupling pin to join the chain. It usually takes three hands. By grinding the ends of a cheap pair of adjustable pliers as shown, it is possible to hold the chain together with one hand while inserting coupling pin with the other.



New York, N. Y. S M ELONKA

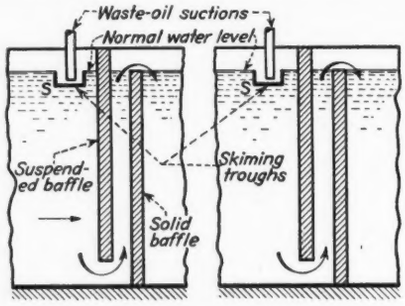
Skimming Pool Improves Cooling Tower

OIL-CONTAMINATED COOLING WATER pumped over a cooling tower eventually coats the surfaces with a slime. A cooling tower in this condition, if permitted to dry, is very inflammable and, once afire, defies all extinguishing efforts. One such fire completely consumed a 140-ft tower in less than 20 min.

At the plant of the Talco Asphalt & Refining Co, Mt Pleasant, Texas, an oil-skimming pit insures that only clean water goes over the tower, see photo and diagram. The concrete pit, 12 ft deep, is divided by vertical baffles into four sections. The baffles are built integral with the pit itself, preventing longitudinal collapse as well as skimming oil off the water surface.

All water enters the pit at one end and flows slowly toward the first suspended baffle. This wall directs flow downward to the bottom where the water is reversed by the floor-supported baffle and flows upward and over its top into the second section, and so on into the fourth section of the pit. From here the clear water is pumped over the cooling tower before being recirculated through the plant.

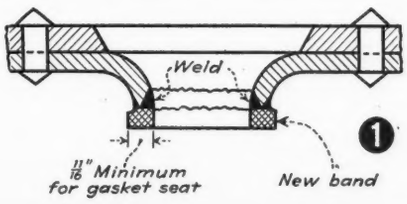
Channel-form skimming troughs *S*

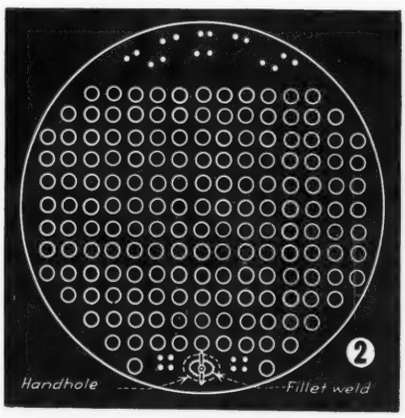


hung just ahead of the suspended baffles are set so that current action will carry the oil from the surface into the channel section, from where it is pumped out and disposed of in a waste pit. When oil is being pumped out, the skimming troughs are raised slightly above the water surface.

Rust and other matter picked up by the water on its way through the plant are deposited in the pit. This has greatly increased plunger and packing life in the water-circulating pumps.

Longview, Texas ELTON STERRETT



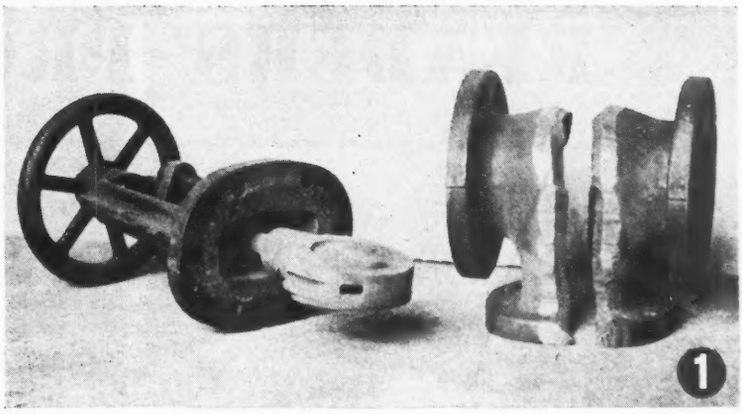


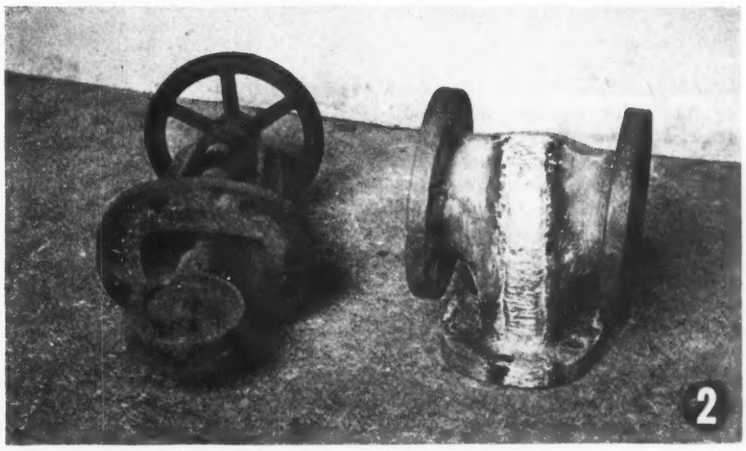
Don't Always Blame the Gasket

WELDING IS SOMETIMES USED, as in Fig. 1, to repair edges of a handhole in a boiler, Fig. 2, where the plate has deteriorated by external corrosion. Welding a new ring to an old corroded plate is often quite different from welding to new metal. Even though necessary care is taken to wire-brush clean all surfaces to be welded, complete fusion is not always obtained.

Sometimes incomplete fusion causes the weld to break its bond between the ring and the edge of the opening in the plate. This break may be a hairline crack for ½ in. or more in a circumferential direction and leakage occurs, which shows at the gasket surface and very often may lead to believing there is a defective gasket. In one plant the gasket was changed a number of times before it was discovered that the weld was not properly made. This trouble was corrected by chipping back the weld metal where it was not completely fused and rewelding that section.

Chicago, Ill. C A ARMSTRONG





Welding Repairs Cracked Valve

THE BODY of a 6-in. cast-iron gate valve in a high-pressure oil line, cracked in two, see Fig. 1. To replace the valve would have required several days, but a repair was made in 6 hours by bronze-welding. Fig. 1 shows the two halves of the valve veed at the crack ready for welding. These were then pulled tightly together by a clamp made of a flat piece of iron across each port with a through bolt.

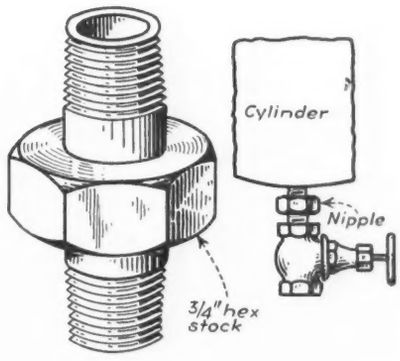
After the two parts were tack welded they were preheated with a blow pipe and the welding job completed, Fig. 2. Truing up the gasket joints and dressing up the seats completed the repair, after which the valve was reassembled and returned to service.

Philadelphia, Pa. F F MOONEY
The Linde Air Products Co

Improved Engine Drain Nipples

WHEN IN CHARGE of several small engines exposed to the weather and other severe conditions I had trouble with the drain nipples breaking off from the engine cylinders. These nipples rusted and deteriorated from galvanic action, which made them difficult to remove. Then occasionally they would be hit by some object and broken off, which added to our difficulties.

To remedy the trouble I made new nipples from standard ¾-in. hexagon brass stock as shown in the figure. I turned down this stock in a lathe to the proper diameter and threaded it at both ends, leaving a hexagon section in the middle for a nut. The nut permits



putting the nipple in or taking it out with an open-end wrench. Therefore, it is not subjected to the collapsing force of the ordinary pipe nipple to which you must apply a pipe wrench.

New York, N. Y. S M ELONKA

READERS' PROBLEMS

Questions from Our Readers

Diesel Rings Break

Question 1

IN OUR 2-CYL, *2-stroke-cycle, 257-rpm, 100-hp semi-diesel, the piston rings persist in "snapping" even immediately after rings and pistons have been cleaned. We have had no lubrication troubles and almost no ring sticking, in 4000 hours of operation. Breakage of the rings occurs only at the ends where they are pinned to prevent turning on the piston. The snapping noise seems to come from the same cause as the breaking of the ring ends. There is no sign of excessive wear either on ring seats or cylinder walls. Can some* POWER *reader suggest a reason for this difficulty?*—TSA

Making a Jet Pump

Question 2

WE NEED *a small pump to lift water from an engine flywheel pit, and thought of making a steam-jet unit for the purpose. Have any* POWER *readers made such a device from fittings available around a power plant? We would like to get some suggestions.*—ESB

SUITABLE answers from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

Turbine-Exhaust Pressure

Answers to April Question 1

The Question

IN TAKING ROUTINE DATA *on turbine operation, we instruct the turbine operators to compute the absolute backpressure by taking the difference between the barometric pressure and the mercury-column vacuum gage. There are, however, two other ways of determining the exhaust pressure; by simply reading the absolute-backpressure mercury-column gage, or by observing the temperature of the exhaust steam and determining the absolute pressure, in inches of mercury, from the steam tables.*

In checking these three methods we find that they do not agree, although the two gages are tapped into the condenser at the same point. The "temperature" method, naturally, indicates a higher backpressure than the gages, since leaving losses increase the steam temperature. We would like to get information as to which method is to be preferred.—EWR

Use Temperature

OUR EXPERIENCE in taking routine data on turbine operation shows that it is best to read temperature of exhaust steam and determine the exhaust pressure from the steam tables. It is admitted that this is not the most desirable method from the standpoint of absolute accuracy, but in general we find it gives us much more consistent and, therefore, more valuable data for comparative purposes. I think this can be explained by the fact that it is much easier for an operator to read an exhaust-hood thermometer to an accuracy of 1 F, corresponding to about 0.03-in. Hg, than it is for him to read a barometer and vacuum gage to the same degree of accuracy.

To illustrate the magnitude of the error introduced by using exhaust-hood temperature, the following differences in pressure were found on a typical turbine: at full load, the temperature showed 0.06-in. Hg higher vacuum than the average of two mercury columns connected at the condenser inlet flange. At 30% load, this difference dropped to 0. For our daily routine readings, used primarily for comparison and general checking, this small error does not offset the ease and accuracy of reading a thermometer as compared to a mercury column.

Washington, D. C. C E MILLER

Most Plants Read Both Pressure and Temperature

ALTHOUGH the absolute backpressure mercury-column gage is most popular for obtaining turbine-exhaust pressure, the choice depends largely on what the operator wants and what he is used to reading. The absolute backpressure gage reads directly in in. of Hg at the pressure point. This saves reading a difficult barometer and a mercury-column vacuum gage. This pressure, of course, is not steam pressure but rather the pressure of the steam and air mixture, if measured before the air is removed, as is usual. The true steam pressure can be obtained only from the temperature, as long as the steam is on or below the saturation line.

For example, take an absolute pressure reading of 2-in. Hg and a steam temperature of 98 F, both leaving the turbine. From the steam table, 98 F corresponds to a pressure of 1.84 in. Hg, which means that partial air pressure is 0.16 in. Hg. If condenser pressure is taken after air removal, the steam pressure will rise from 1.84 to 2 in. Hg, the total pressure. This takes place adiabatically and isothermally, so that the result of removing air is a slight increase in moisture.

Under some conditions of operation—light load, high backpressure, high extraction—exhaust steam may be superheated. A temperature corresponding to a higher saturation pressure than the actual pressure will show this condition. In such a case, the condenser shell will have to be drilled to measure temperature of steam after it has passed over several rows of tubes and become saturated. Actual steam pressure can then be obtained. Hotwell temperature does not mean anything in respect to pressure since even with a hotwell reheater the water temperature is below saturation.

To summarize: In most plants I have seen operators read both exhaust temperature and pressure, using either an absolute backpressure gage or a combination of two gages. Unfortunately, many of these operators do not get full value from these readings as they do not use the information on partial air pressure to determine air leakage. However, this practice is spreading.

Staten Island, N. Y. R ATLAS

Starting Oil Burner

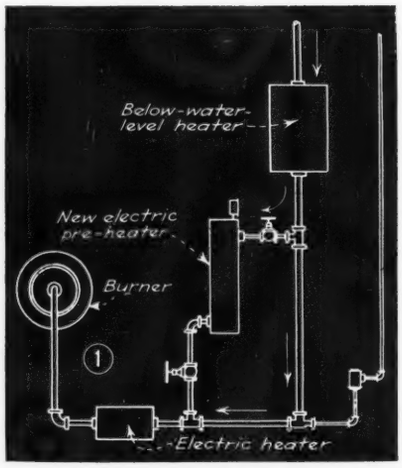
Answers to April Question 2

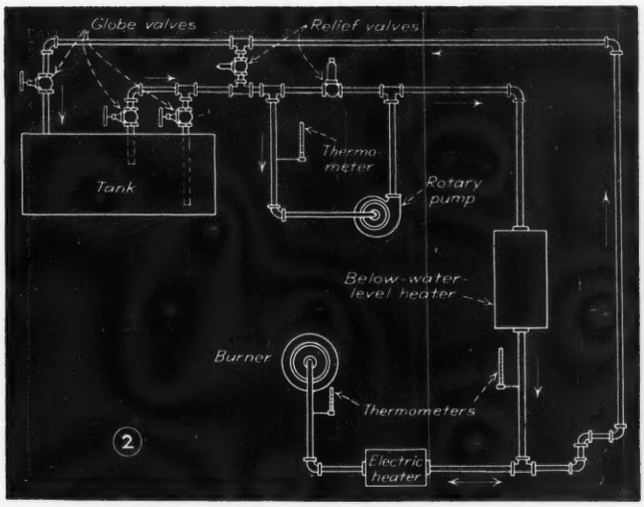
The Question

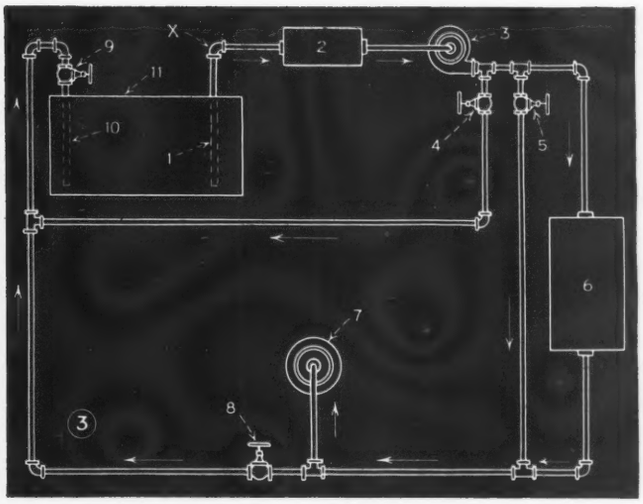
THE OIL-PIPING SYSTEM *for a low-pressure heating boiler uses Bunker C. No heat is supplied at night, except to prevent freeze-ups in severe weather. When the thermostat calls for heat in the morning, we have trouble getting the burner started because the below-the-water-level heater is practically inoperative until the boiler gets going. Is there any way we can change this hook-up to heat the oil before the boiler starts, or is there any other solution?*—PNN

Add Electric Heater

PNN DOES NOT GIVE either the type or capacity of the burner, but presumably it is a rotary, in which case Bunker C or No. 6 oil would have to be at or brought up to 150-160 F to insure satisfactory atomization. The capacity of the







present electric heater isn't given but an additional electric heater installed as shown in Sketch 1 should solve the problem. If PNN will remember that one Btu will raise the temperature of one lb of oil approximately two degrees, and that there are 3412 Btu's in a kwhr, he can easily figure the required heater capacity.

The heater should be thermostatically controlled, as it is surprising what a solid job No. 6 oil can make if it overheats and carbonizes. The heater can be wired to operate solely when the burner is running. Then the current can be cut off and the heater taken out of the oil circuit by hand when the water heater provides enough heat. However, if the electric heater is under thermostatic control no harm is done if left to take care of itself as the control will cut the current off when the oil comes up to temperature.

Bloomfield, N. J. J O G GIBBONS

Check Controls

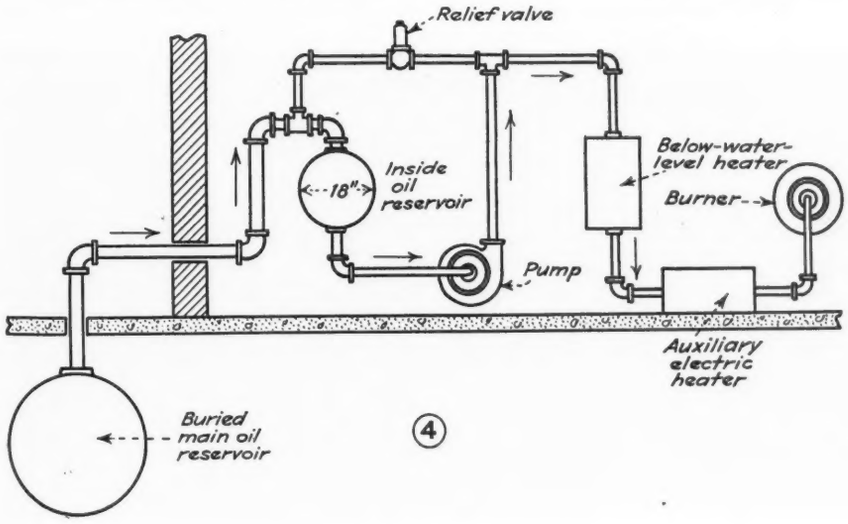
MOST LIKELY PNN'S DIFFICULTY comes from low oil temperature. From the statement "when the thermostat calls for heat in the morning" I assume that the plant is fully automatic. I suggest that he first check the cut-in and cut-out points of the electric-heater temperature control, which when wired correctly with the relay will not permit the burner to start unless a predetermined oil temperature has been reached. The electric element should be thoroughly cleaned of carbon, etc, as any coating will retard heating. Also check ignition, and primary and secondary air supply.

PNN fails to give the size of the fuel tank. If storage capacity is large, disconnecting the return line at the point where it enters the suction line and continuing it direct to the tank will improve conditions. High- and low-suction lines will be of advantage since the cold oil remains in the lower part of the tank. Installing thermometers in the suction line, below-the-water-level heater and electric heater will enable PNN to observe and check oil temperature changes at all times. See Sketch 2.

New York, N. Y. CARL BACHMANN

Change Hookup

SKETCH 3 SHOWS A HOOKUP which aims to store enough heat in the fuel when the plant is in operation to carry over the idle period. The following points outline the scheme: (1) if possible, install heating coil around bottom of suction line, (2) change electric heater to this point, ahead of fuel-oil pump (3), (4) follow new discharge hookup for fuel-oil relief valve, (5) install gate valve for heater bypass line, opening it when starting and closing it when steam passes through the heater (6).



A spring-loaded backpressure valve (8) holds correct pressure on burner (7). A check valve (9) should be installed as close to the tank as possible and the return line (10) will be most effective if tube enters tank at maximum distance from the suction line and extends close to the bottom of the storage tank (11). If necessary, install an anti-syphon valve at *X*. The suction line should be not less than the diameter of the suction opening to the fuel-oil pump, and discharge, bypass, and return lines should not be smaller than the discharge opening in the pump. Insulation on all equipment will give better results.

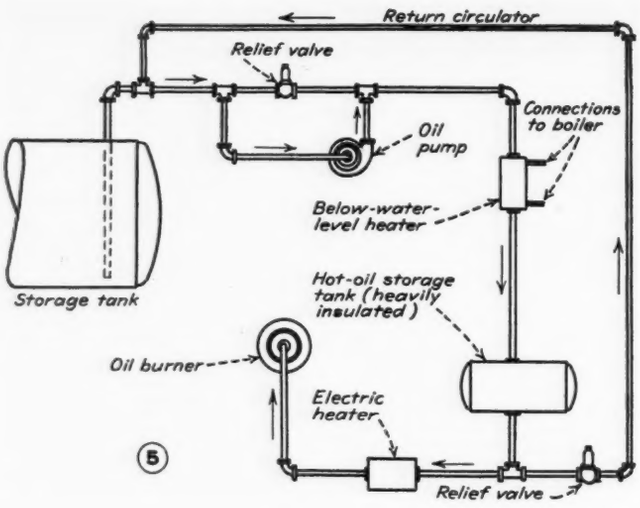
Baltimore, Md. O M T

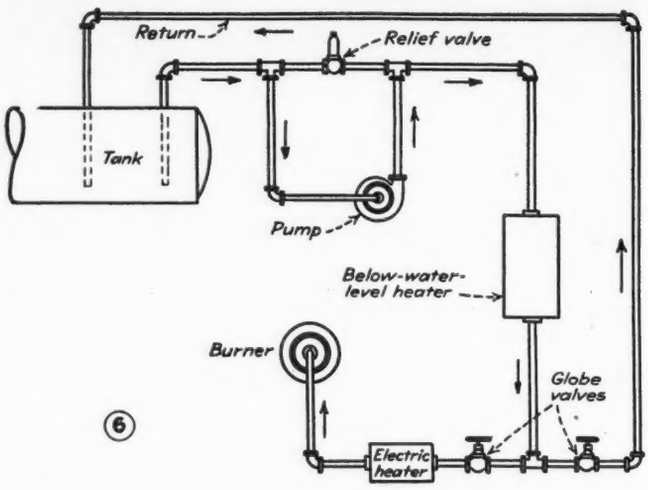
Try Indoor Reservoir

PNN DOESN'T STATE definitely where the storage tank is. Most municipal codes require that all fuel-supply tanks must be outdoors, buried below the surface and a specific minimum distance from the building. Under these circumstances it is likely that PNN's trouble results from the excessively low oil temperatures likely to be found with such a setup. Although a properly installed buried tank receives a certain amount of protection from extreme low temperatures, the residual oil in connecting lines (between outdoor tank and oil pump in boiler room) is sure to be at a low enough temperature after standing all night to give burner trouble prior to operation of the below-water-level heater.

I remember a case where the operators had the same troubles as PNN. Finally they decided to install a small 18x36-in. oil reservoir in the boiler room, in the oil line to the burners, near the pump suction, see Sketch 4. Low overnight outdoor temperatures had little or no effect on temperature of oil in this tank and starting temperature in the morning was close to that previous to shutdown the night before. No trouble was experienced after this change; the inside reservoir was big enough so that the below-the-water-level heater came into action before the reservoir was empty. It is only necessary to see that the inside reservoir is full when shutting down at night. This is always the case unless there is a serious leak.

Cleveland, Ohio A R CIOTTI





Cut Down Starting Rate

IT IS POSSIBLE TO PROVIDE an electric heater of sufficient capacity to heat the oil when starting up, provided a conservative rate of flow is maintained. It may be that PNN is attempting to operate the burner at too high a rating for the capacity of the existing electric heater, in an effort to raise steam quickly. The electric heater should be turned on at least 2 minutes before the burner motor is started or until oil temperature reaches approximately 160 F. If the burner tip is interchangeable, using a smaller tip and taking a longer time to start may maintain the oil flow at a rate within the heating capacity of the electric heater.

If the electric heater still won't handle the job, install a heavily insulated hot-oil storage tank between the below-the-water-level heater and the burner, as shown in Sketch 5. Assume that the boiler contains 1000 gal or 8330 lb of water at 80 F when starting up and that a water temperature of 200 F is necessary to heat the oil properly. If the oil has a heat content of 18,000 Btu at an over-all boiler efficiency of 65%, 11,700 Btu will be absorbed by the boiler water per lb of oil burned. At the temperature of 200—80=120 F, 120 Btu per lb of boiler water, or 120×8330=1,000,000 Btu will have to be liberated by combustion before the below-the-water-level heater can take hold. To get the size of hot-oil tank required, divide 1,000,000 by 11,700, which gives 85.4 lb of oil, or about 15 gal.

It is important that the hot-oil tank be constructed safely for a pressure at least equal to the relief valve setting, and according to the A S M E Code for Unified Pressure Vessels. This is a requirement in some states.

Canton, Mass. H M SPRING

Add Globe Valves

I OVERCAME THE TROUBLE PNN has by installing globe valves as shown in Sketch 6 and by returning heated oil to the tank at a rate adjusted by the new valves. This will keep the oil to about 90 F in the morning, if normally burned at 180 F. I also built a form around the tank and covered it with about 4 in. of sand. This plan worked well all winter.

Chicago, Ill. ADOLPH GABRIEL

Bypass the Burner

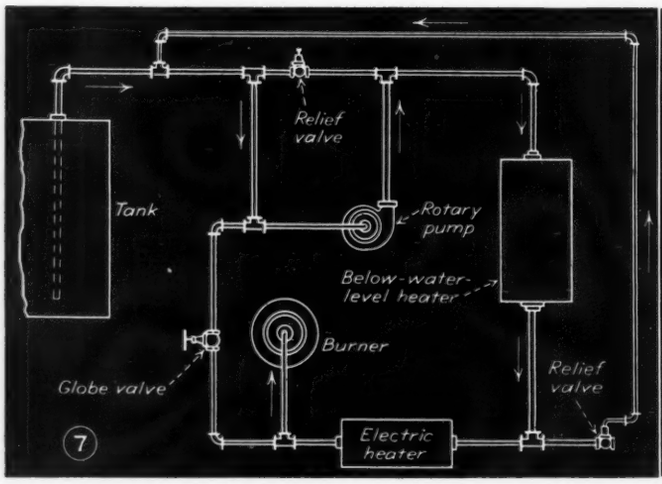
THE PROBLEM PRESENTED by PNN is quite a lot like one we faced a few months back. I suggest that PNN connect the outlet side of his electric heater with the suction side of the pump, inserting a globe valve in this line, see Sketch 7. This is just a bypass line to get the heated oil from the electric heater back to the pump and thus keep the warm oil circulating through the heater until ignition temperature is reached. This set-up works nicely for us and I feel sure it will do a good job for PNN in solving this particular problem.

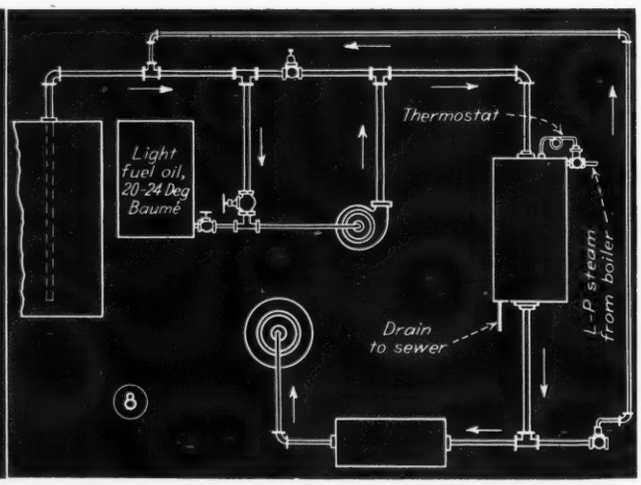
Wilmington, Del. J H CRONIN

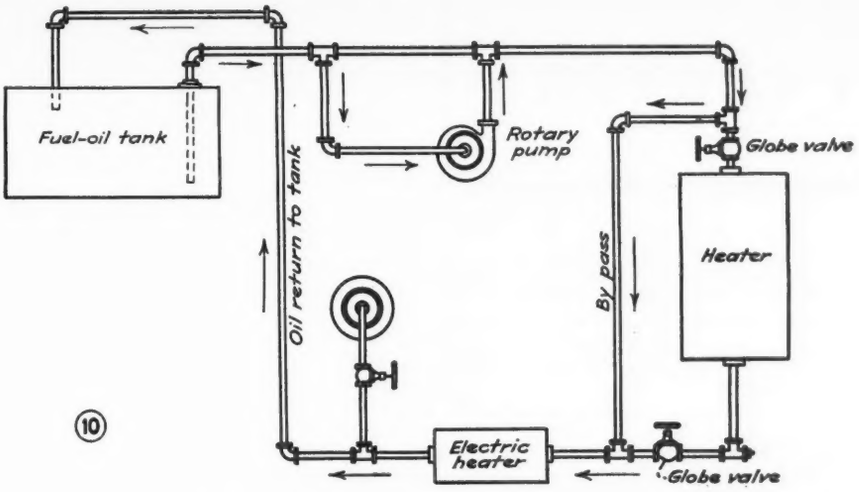
Install Heated Auxiliary Tank

I SUGGEST PNN INSTALL an auxiliary electrically heated tank holding enough oil to cover the time between starting up and placing the below-the-water-level heater in operation. This tank should be installed about 15 ft high with a valve close to the outlet. For automatically starting in time to heat the contents of the tank before use, a combination time-clock and starter can be installed. The tank can be filled in the evening. To make operation easy a few additional valves should be built in, as shown in Sketch 9. To fill the auxiliary tank, open valve *B* and close *A*, *C*, and *D*. To start in the morning, open valve *C* and close *A*, *B* and *D*. For normal operation, open *A* and *D*, close *B* and *C*.

Vancouver, B. C. ALEXANDER KAPLAN







⑩

Use Light Oil for Starting

SEVERAL REMEDIES to PNN's problem suggest themselves. The first and least expensive is a small steam line from the highest available point in the boiler, say the air vent connection, to the heater, thermostatically controlled. This should be enough to keep the temperature of the Bunker C oil somewhere near the atomization point even with only the low-pressure steam remaining after shutdown. The condensate must go, of course, to the sewer as the heater is below water level.

Another remedy would be to install an auxiliary tank to contain light fuel oil of about 20 deg Baumé gravity, the tank to be connected as shown in Sketch 8. Before shutting down the pump at night, switch to the auxiliary tank so that the system will be full of light oil from the pump to the burner. The low fire point of this oil should enable starting the plant with a minimum of smoke or ignition troubles. The light fuel is only used, of course, until the system is warm enough to change to the heavy oil. Final choice of a remedy must be based on economic considerations, of course.

Kearny, N. J. GEORGE MCNALLY

Need a Bypass

PNN'S HOOKUP makes no provision for bypassing fuel oil around the system. I suggest he install a tee just before his below-the-water-level heater and another just before the electric heater. Between each tee and heater install a globe valve and then connect up the bypass line as shown in Sketch 10. By using another tee beyond the electric heater, he can pass part of the oil back to the supply tank. To start in the morning, all PNN has to do is bypass oil through the system until the temperature reaches a satisfactory point for burner operation.

Philadelphia, Pa. W T MULLEN

Install Heating Coil

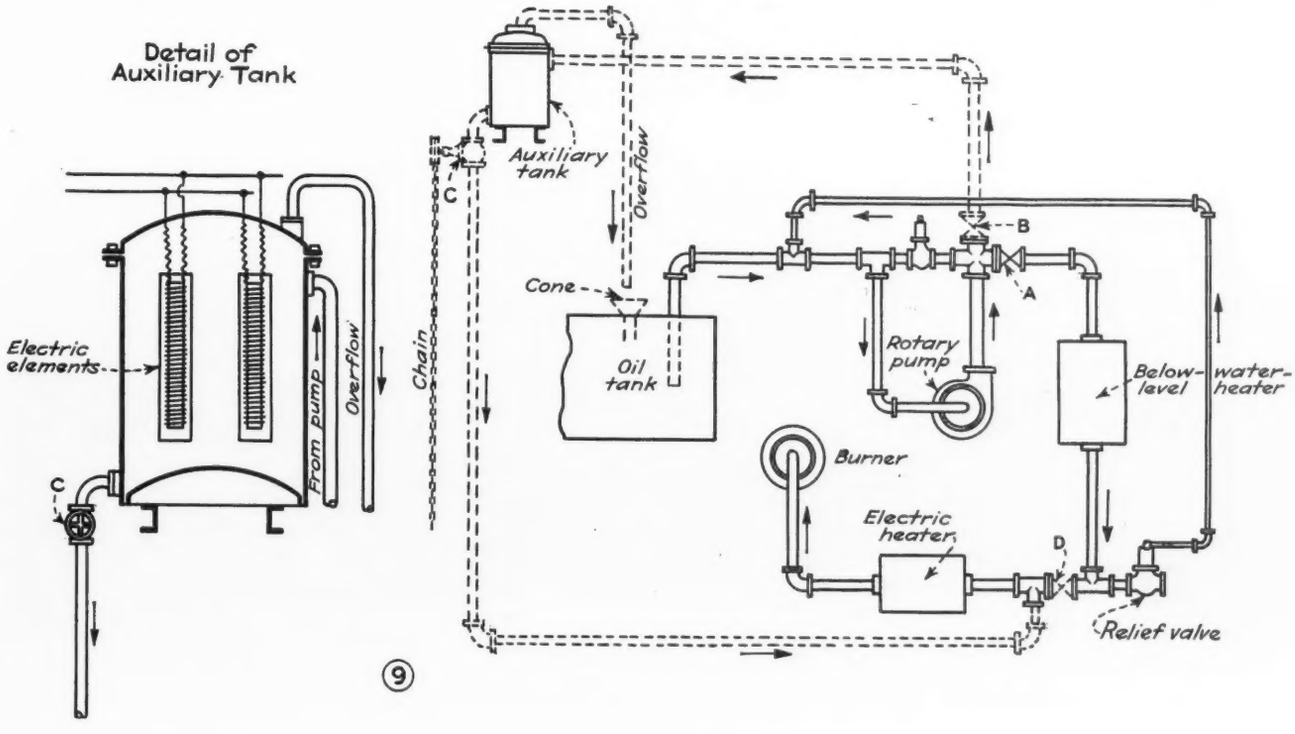
PNN SHOULD INSTALL a steam heating coil in the oil-storage tank to keep the fuel at proper temperature for the pump to handle. This coil should be controlled by an automatic valve regulating steam flow according to oil temperature in suction line to pump. The return line from the steam heating coil should be trapped.

The relief valve at the pump discharge and the relief valve near the burner should be piped back to the oil-storage tank through a common return line. An automatic electric heater, which will cut in when the oil gets too cold for satisfactory burner operation and cut out when oil comes up to proper temperature, will give best results.

Woodside, N. Y. G D SOLD

EXTRA POSER

Harry Spring writes to tell of a question in a Province of Quebec boiler-inspector examination which asks, in effect, how much energy an exploding boiler, containing 60,000 lb of water, releases. Before checking our slide-rule pushing, try to guess—a dime gets a dollar you won't be even close. For a slow-motion picture of what happens, imagine water at 175 lb pressure in a cylinder. The first slight drop in pressure causes a small part of the water to flash to steam, which pushes against the piston as it expands. This process continues, with more and more water flashing to steam at lower and lower pressures. The energy released is the sum of the work done by expansion of the steam, down to atmospheric pressure. This amounts to about a million Btu or a mere trifle of 778 million ft lb—enough to lift a man-sized locomotive (400,000 lb) about 2000 ft straight up.



⑨

ARGUMENT CORNER

Scotsman's Goat Gets Bounced

MR JOHN M GORRIE, in the Argument Corner, April POWER, appears unfamiliar with the generally accepted meaning of the terms "high pressure" and "low pressure" as used in American practice of an earlier day. The former term was applied to non-condensing installations, the latter to equipment operating condensing. Of course, initial pressures could be considerably lower for the same power with the condensing installation.

An interesting point in this connection is that about 1805, Colonel John Stevens tried, without success, to interest James Watt in the advantages of a "high" pressure of about 50 lb per sq in.

The reason for the "unholy" high-pressure tug is fairly obvious. A non-condensing plant, such as in a locomotive or tugboat, can install a smaller, lighter and cheaper boiler by using exhaust steam to force the fire. Where fuel prices are not prohibitive and varying conditions of operation require maneuvering in shallow water, almost any expedient that serves to reduce the draft of a vessel can be justified.

Had Mr Gorrie been among the interested spectators in 1812 when Bell's Comet was "running between Glasgow, Greenock and Helensburgh, for passengers only", he would have seen no walking beam. The Comet had a half side-lever engine. The last vessel fitted with side-lever engines was the Cunarder, "Scotia", built at Glasgow in 1862. In passing, the boiler pressure carried in the "Scotia" was 20 lb per sq in.

The " . . . boilers with the fire under the shell, and the shell sitting on brickwork", is a good description of the hrt boiler, for many years the standard type in small plants all over the U.S. The British equivalent of the Yankee hrt is the Cornish or Lancashire boiler, usually fitted with Galloway tubes. In this boiler, the fire is in one or more internal furnaces, the shell rests on brickwork and gases pass under and around the shell. Seems almost a distinction without a difference.

There is scarcely an argument against the "scandalous" waste of non-condensing operation under unsuitable conditions. However, fuel cost, type of labor available, injection-water supply and probable permanency must be considered, so non-condensing operation may be justified.

Before the days of quotas and point-of-natural-origin laws, the U. S. was the promised land for many persons seeking individual freedom and opportunity. This gave rise to many small industrial enterprises with accompanying small power installations. Despite this condition, reciprocating engines indicating 7365 hp were installed and operating in this country as long ago as 1906. Those rigs were scarcely a project for the Moldemakers' Society.

Judging by appearances, which is often an error, one might be led to believe that the choleric Caledonian was influenced more by emotion than by reason.

Arlington, Va. W H MCKINNEY

More About American "Bilers"

SOME AMERICAN INSECT must have bitten our visitor from the land of Burns, Watt, M'Andrew and Colin Glencannon, to cause

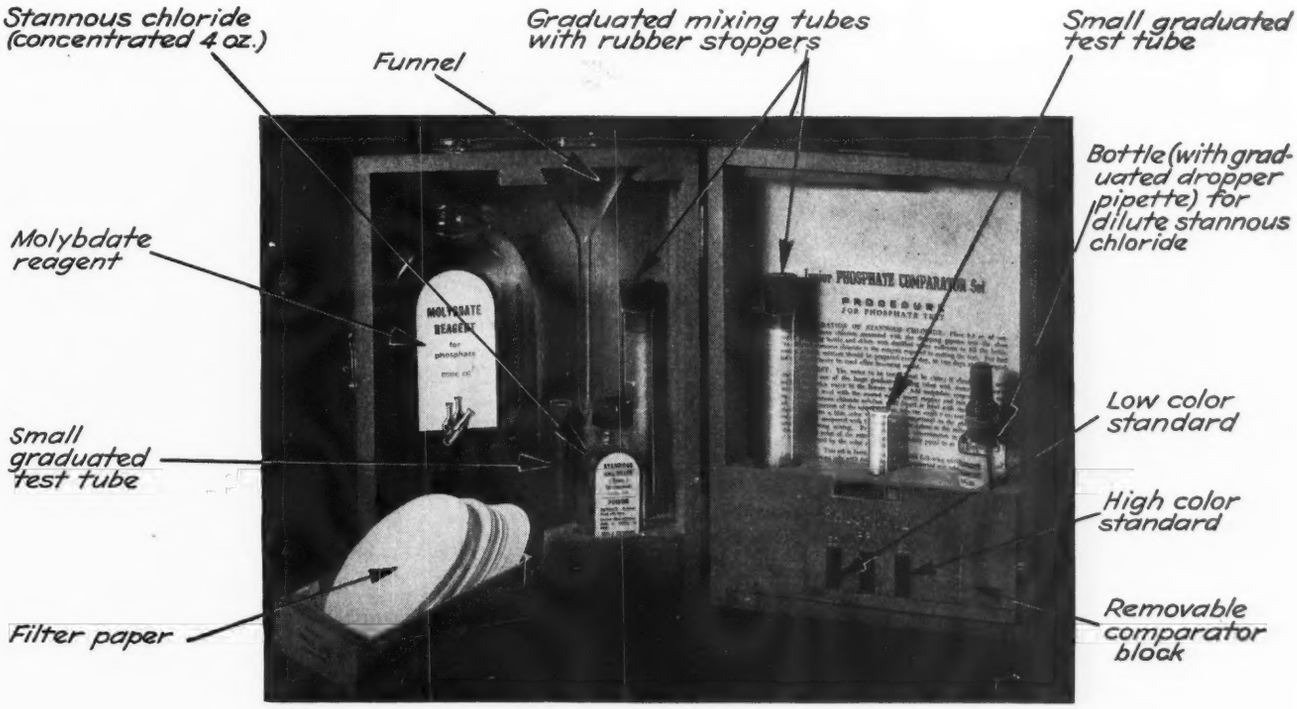
(Continued on page 134)

"Humphries, you're sure your test doesn't indicate *some* corrosive action"

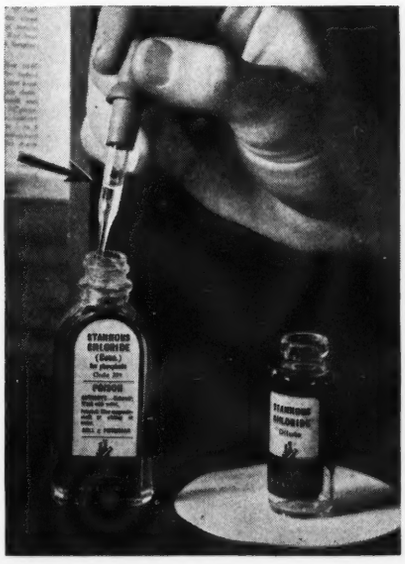
HOW TO TEST FOR PHOSPHATES

By C A NOLL
Chief Chemist
W H & L D Betz
(Photos by POWER)

IN FEBRUARY, this "How To" section described a simple water test kit. March showed how to test for hardness, April for alkalinity and May for chlorides, completing the three most commonly used tests. This phosphate test has been added because many plants are today maintaining residual phosphates in boiler water. Of the several methods proposed for testing for residual phosphates, the color-comparison method, here described, is recommended as rapid and accurate even in the hands of an inexperienced operator.



1 Test kit for phosphates

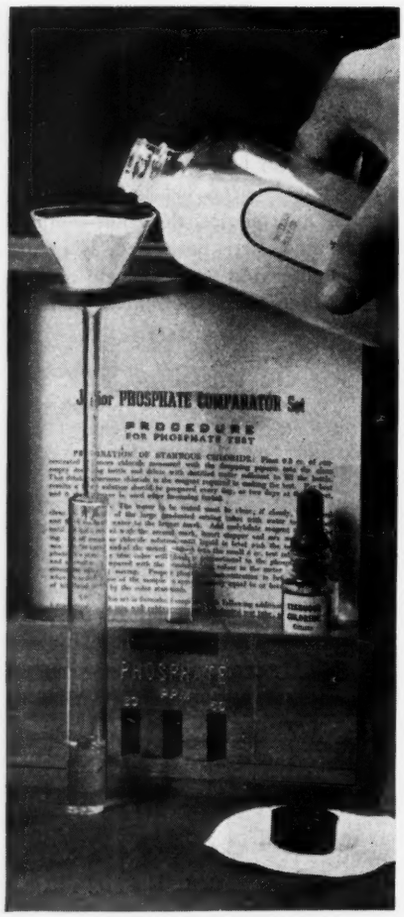


2 First step is to make the dilute stannous chloride solution. Draw up concentrated stannous chloride solution to the graduated mark in the dropping pipette. CAUTION—This is an acid solution and must be handled carefully

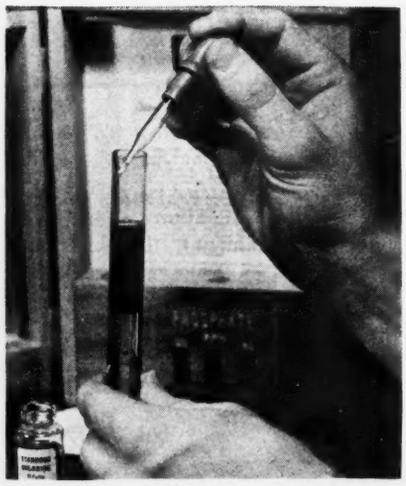
3 Place in the empty bottle marked "Stannous Chloride—Dilute"

4 Fill this bottle up to the neck with distilled water, or water free from phosphates. (Leave room to insert dropper.) Place dropper in the bottle and shake well. Solution is now ready for use. Make fresh solution every day or two, or when it becomes turbid

(CONTINUED ON NEXT PAGE)

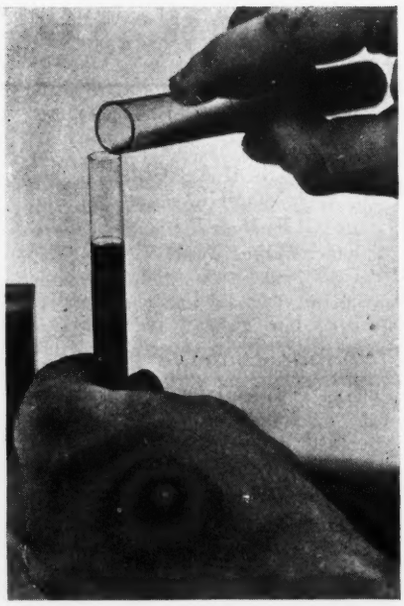


Filter the sample of previously collected and cooled boiler water, on which test is to be made. Pull out filter stand on top of case, insert funnel and filter paper. Place mixing tube under long-stem funnel and pour through a small portion of the boiler water—enough to fill the mixing tube exactly to the bottom graduation (5 cc)



7 Now add dilute stannous chloride, using the dropping pipette, to bring level up to third graduate mark. This requires 2.5 cc. A blue color will immediately develop if phosphates are present

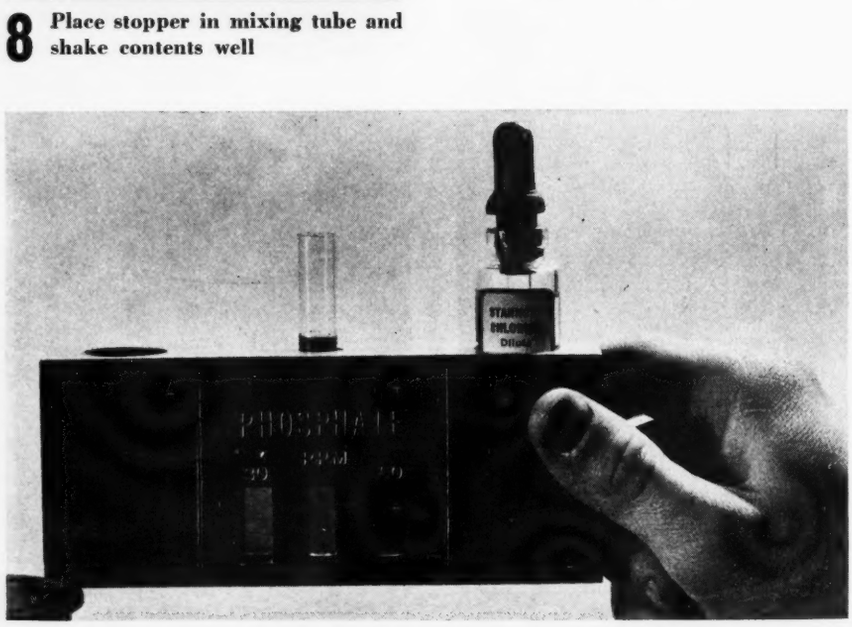
8 Place stopper in mixing tube and shake contents well



9 Pour a portion of the mixed solution into the small graduated test tube, filling it to the graduated mark or thereabouts

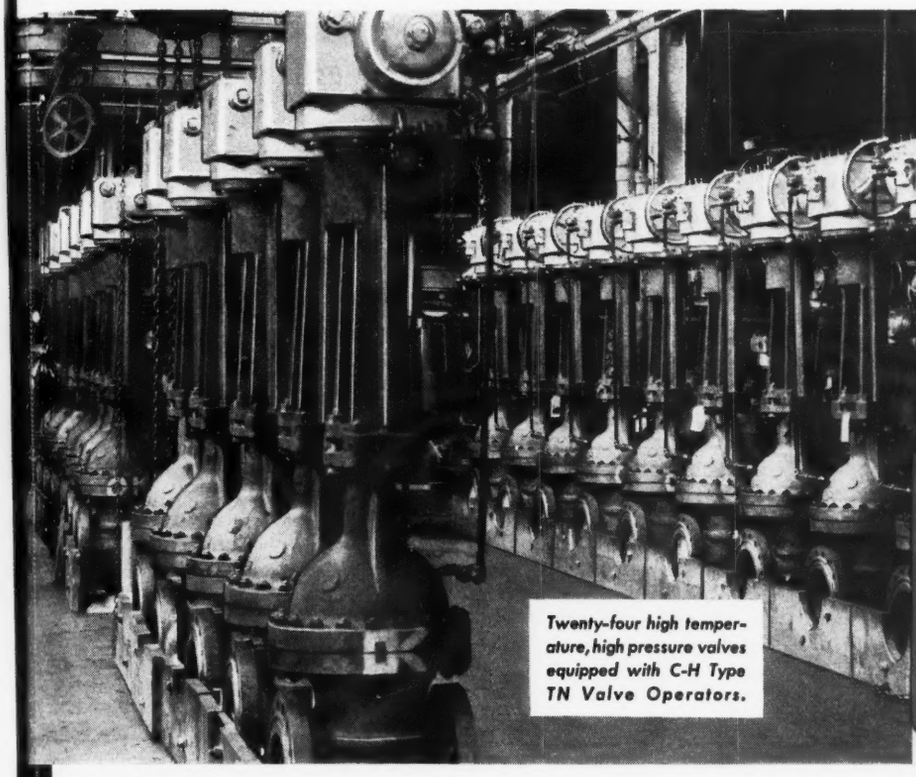
NOTE — The comparator block shown in photo 10 contains a low standard (left) of 30 ppm and a high standard (right) of 60 ppm phosphates. These are the limits most frequently maintained. Other high and low standards may be substituted to give any desired range.

6 Next, pour in molybdate reagent from quart bottle to bring the level of the liquid up to the second graduated mark in the mixing tube. (This will require 10 cc molybdate reagent)



10 Place the small tube in the center hole of the comparator block and hold up to the light. If intensity of the color lies between that of the two standards in the block, sufficient residual phosphates are present. If lighter than the low standard, phosphates are too low. If the blue color is darker than the high standard, phosphates are too high

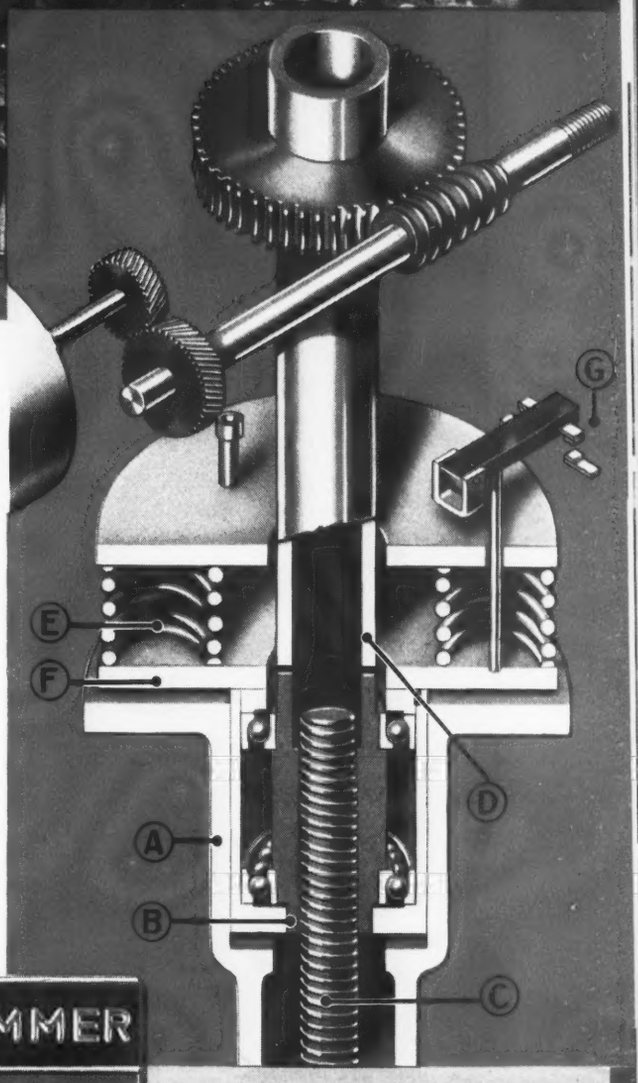
The Era of Properly Seated Valves



Twenty-four high temperature, high pressure valves equipped with C-H Type TN Valve Operators.

on high temperature, high pressure lines

The trend toward higher and higher temperatures and pressures in power plant operation turns all eyes on Cutler-Hammer Thrust Seating Valve Control. Available for installations approaching 1000 degrees F. and pressures up to 3000 lbs., Cutler-Hammer Type TN Valve Operators herald the era of properly seated valves. They seat the valve through heavy helical springs. Closing position is controlled directly by the thrust on the valve stem. At the moment of accurate tight seating or *equivalent stem thrust*, the driving motor is cut off and all drift is absorbed by the heavy springs. Appreciable metal changes due to extremes of temperature or atmospheric conditions are automatically compensated since the springs retract under expansion of valve parts and drive forward when valve parts contract. Accurate tight seat is maintained at all times. Thus, the desired force, regardless of what that may be, is always under safe control—properly maintained for accurate operation under the most extreme conditions. . . . A vital necessity in high temperature, high pressure practice, the C-H Thrust Seating Valve Control is equally valuable in low pressure water, liquid or gas-flow valves. Operating entirely on the stem thrust encountered, it protects valves from damage due to foreign obstructions. . . . All valve manufacturers supply C-H Type TN Operators as standard. Consulting engineers include C-H Type TN features in their specifications. Investigate it *now*. CUTLER-HAMMER, Inc., *Pioneer Electrical Manufacturers*, 1209 St. Paul Avenue, Milwaukee, Wisconsin.



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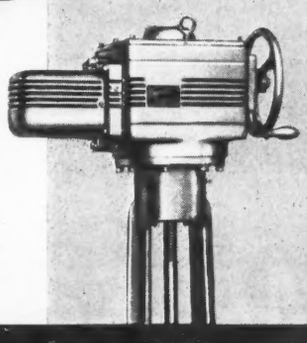
- Provides for large temperature changes in high temperature steam valves. No periodic "back off" necessary. No dismantling of valve to "unfreeze" the parts.
- Provides for accurately controllable full power drive, easily adjusted for service conditions. Reduces strain and wear and tear.
- Provides high speed operation where required (up to 80" per minute) on high pressure valves.
- Provides ADEQUATE protection against artificial obstructions such as gravel or a piece of wood in the valve.
- Delivers an unseating "hammer blow."
- Free hand wheel operation available at any time.

SPECIFIC METALLURGY. Steam temperatures approaching 1000° F. eliminate the possibility of haphazard choice of valve materials. C-H units employ the specific alloy and treatment best suited to the function of each part.

MOTOR INSULATION. C-H valve unit motors have class B spun glass, flame-proof insulation, standard for a 75°C. rise.

TIGHT SEATING OR POSITION SEATING. Some types of valves demand tight seating. Others properly should be position-seated. C-H valve control provides either method.



THE VALVE OPERATOR

Construction

A: Valve yoke. B: Yoke nut. C: Valve stem. D: Driving member. E: Heavy steel helical springs. F: Movable plate which together with springs (E) takes the thrust. G: Thrust Switch.

When the stem thrust equals that required to seat the valve, the driving yoke nut backs up against the pressure springs and trips the thrust switch.

Ending the Instrument Dilemma

By C A LITTLE

In Rochester, N. Y., the Mechanics Institute pioneers in training men to design, install, adjust and maintain automatic controls. Student reception is enthusiastic — here's why

Clifton B Graham, young Eastman Kodak engineer who had a prominent part in starting this course in power-plant instruments and process controls, explains operation of the time-cycle controller to members of his class

▶ MODERN AUTOMATIC CONTROLS for manufacturing and power-plant operation, multiplying in number, present a growing problem. Who is to keep instruments working properly to meet requirements of different processes so that products will be at their best, waste prevented, and labor costs kept within reasonable bounds?

A reply has been given, an answer with a heart in it—one that is sending workers, ranging all the way from laborers to college graduates, back to school. Instead of permitting perplexity to remain enthroned, the Rochester Athenaeum and Mechanics Institute, now 111 years old, is doing something about it.

This famous old school, which numbers thousands of skilled workmen, and many industrial leaders, among its alumni, has started a course in power-plant instrument and process control for operators, maintenance men, engineers and repairmen interested in the design, installation, adjustment and maintenance of modern automatic controls.

The course is under the supervision of Cyril Donaldson, counselor in mechanical technical subjects of the evening school. The instructors are two young engineers — Clifton B Graham of the Eastman Kodak Co and Ralph Clarage, sales engineer of the Taylor Instrument Cos.

Before industry was modernized, tending the few plant instruments in use was a simple matter, generally looked after by one of the workmen as a sideline. But when manufacturing plants began to use industrial instruments in large numbers not only to improve the quality of their products, but also to cut waste and to produce more economically with labor, the problem of keeping them functioning took on new importance.

Instrument companies began training more men. Their engineers serviced instruments in other plants, of course, but they were not always readily available and delays were costly. Some large industries established instrument departments and trained their men through apprenticeship systems. But that was expensive; carried out under difficulties in trying to make a school out of a shop.

The problem was growing after Mr Graham completed his course at the University of Illinois and went to the engineering department of the Eastman Kodak Co.

Here was an industrial center devoted almost exclusively to the manufacture of quality products calling for the highest technical skill and workers of high standards of intelligence. Here also was an educational institution where thousands of them had received technical training—one in which employers and employees have implicit faith. It had other power courses.

A Problem Solved

Why not solve the instrument problem right there? The young engineer went to see Mr Donaldson, described the increasing need for competent instrument men in factories and asked that a course be instituted to help supply them. The counselor agreed that this necessity existed, said others had spoken to him about it—and he wanted such a course—but financial provision had not yet been made for it.

"I will teach it myself," said Mr Graham when the question of finding an instructor was presented. That removed one obstacle. When they talked the matter over with Dr Mark Ellingson, president of the Institute, and Byron G Culver, supervisor of the evening school, both gave enthusiastic approval.

Accordingly, a modest announcement was made that the new course would be started last September; the exact date was fixed, and Mr Graham acquired some pamphlets describing various instruments. Then he went to the Insti-

(*Continued on page* 116)

In one plant, at La Porte, Indiana, Allis-Chalmers Mfg. Company have installed 248 Yarway Impulse Traps. Evidence that this company, like many other leading manufacturers, is gradually standardizing on the Yarway Trap.

Why don't you try a Yarway Trap in your plant? Let it demonstrate its quick heating and sustained heating efficiency. Let it show you how to save money on installation, maintenance and fuel consumption.

And you, too, will consider standardizing on this new kind of trap that works on an entirely different principle—that has won widespread preference on its superior performance on the job—when you find out that it is usually cheaper to buy new Yarways than to repair the old traps now in service.

See your industrial supply distributor. He sells them. Sells more of them than any other trap. Or write for Catalog T-1735.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia

YARWAY IMPULSE STEAM TRAP

Ending the Instrument Dilemma

(Continued from page 114)

tute to await the arrival of candidates for a small class.

But instead of the handful that was expected, a multitude came—men who were eager to learn the intricacies of automatic control instruments. They took up all of the room space in the Mechanical Laboratory, overflowing among its machines. This was too many for one class; they had to be divided into two sections and another instructor added.

Wide Representation

Ages of the students ranged from 20 to 50 years, with such a variety of trades as film worker, machine operator, clerk, emulsion worker, steam fitter, experimenter, mechanical engineer, laborer, salesman, group leader, file worker, instrument repairer, foreman and so on.

Since most of them came from the plants of Eastman Kodak and Taylor Instrument, Mr Graham appealed to the latter for assistance in teaching after trying the job alone for a week. Mr Clarage, graduate of Ohio State University in the class of 1930, who had devoted time to instrument research, was assigned to help.

Instead of one class a week, as planned originally, two classes are conducted—on Monday and Wednesday evenings from 7:30 to 9:30 P M. Eleven of these weekly lessons constitute a term, for which the tuition is $6, and the whole course is made up of 33 weekly lessons. The entire cost of tuition is $18.

Nobody Drops Out

It was expected that many would drop out of the class because of the necessity of giving rein to the majority, who had some knowledge of the fundamentals of instruments. There were a few casualties, some who found the course too hard, but most of them buckled into it with the zeal of crusaders, making up for lost time through burning more midnight electricity.

Attending a session of this class, you sense the intense interest of these student workers, leaning forward, eagerly catching every syllable that falls from the lips of the instructor, hurriedly taking notes as they go along, interrupting with questions when they do not understand.

Some of the instruments belong to the Mechanical Laboratory. Others are borrowed for use of the class. Soon it is to tour the Taylor plant, with a lecture and demonstration to follow.

Ralph Clarage, the other half of the teaching team, explains how a Sylphon works

Since the class was started there have been many applications for admission to it, some from persons who are not now working. They were told that there will be a better opportunity next year when the course will be improved out of knowledge gained through experience.

Two Classes Next Year

Although there are now no educational requirements of applicants, Mr Graham believes there should be. He foresees at least two distinct classes next year, one for engineers and the other for those with some knowledge of machinery. Details will be worked out as they go along.

Mr Clarage foresees this instrument class as the forerunner of other groups of students studying power-plant instruments and process control in industrial centers throughout America.

The main thing—the heartening thing—is that a beginning has been made toward providing the technical knowledge of power-plant instruments and process control which many workers need, making them more valuable, opening a new avenue of employment. Also it will insure better products and get rid of the waste which brings losses to all.

It is characteristic of this school, which has a total of 3,500 students, to pioneer. Under the leadership of the late Captain Henry Lomb, Mechanics Institute in 1885 started a specialized and technical program to provide greater educational opportunities for employed artisans and mechanics.

New courses kept pace with the advent of the machine age, as they did in other departments. Business and industry gave this privately endowed, non-profit-making school their support. For that reason, many of its courses have cooperative features under which students alternate studies with work, spending one month in school, the next on a job at a regular pay, and so on.

Other power courses conducted in the evening include air conditioning. Cooling and refrigeration are considered. Trips are made to local plants and installed air-conditioning equipment studied.

Other Courses

Practical domestic warm-air heating is a new course not only for persons engaged in the design, engineering or sale of warm-air heating equipment, but for repair mechanics and fuel salesmen.

There is a series of evening courses for power-plant operatives and others interested in power-plant operation. The list includes steam engineering, diesel engines and practical lubrication. And there is also a credential evening course in power-plant operation for those who wish to follow a planned course of study covering several years.

EXCESS AIR, the thief in the boiler room, is always snooping 'round looking for a chance to snitch some of that costly fuel.

Hays automatic combustion control and instruments effectively throttle this menace. Air and fuel are accurately measured to meet the demand and guard against loss. Regardless of fluctuations steam pressure is kept constant without waste. Fuel is consumed only when needed and the correct amount of air supplied to maintain the most efficient combustion under all load conditions. Write for complete information.

There is a Hays Combustion Control system for every sized plant . . and a Hays representative near you to tell you all about it. Write the Hays Corporation, 905 Eighth Avenue, Michigan City, Ind.

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SINCE 1907 COMBUSTION INSTRUMENTS AND CONTROL

MICHIGAN CITY, INDIANA, U.S.A

ASME Presents New Data on Feedwater, Fuels, Industrials, Water Flow

Spring meeting at Worcester, Mass., May 1-3, hears important papers on problems of high makeup, industrial plant pressures and temperatures, selection of coals, design of oil burners, measurement of water flow and cavitation

▶ THERE IS A TENDENCY in treating boiler feedwater to overtreat and fill the boiler with unnecessary quantities of salts, reported C H Fellows, Detroit Edison Co and chairman of the E E I Committee on Feedwater Treatment. This intensifies the possibility of carryover and requires excessive blowdown. A good fundamental rule, he insisted, is to reduce all salts in the boiler water to a minimum by use of pretreatment precipitation with minimum addition of chemicals to the boiler drum.

Pretreatment involves addition of chemicals and removal of the reaction products by settling or filtration, or it may involve actual evaporation. Internal treatment concerns addition of chemicals in such a manner that they remain in the boiler water circulation. In either case the basic objectives are: (1) to prevent scale, (2) eliminate corrosion, (3) prevent carryover, and (4) inhibit caustic embrittlement.

Of these, corrosion and carryover represent major problems to operators of high-pressure plants. Rule of thumb methods, he added, must be discarded, making way for the highest skill and most precise manipulation possible.

Oxygen and carbon dioxide are the two major offenders as regards corrosion; deaeration and adding small amounts of oxygen-absorbing chemicals such as sodium sulphite, colloidal iron or organic materials are remedies. Lack of proper circulation in high-pressure boilers, warned Mr Fellows, can lead to creating an environment favorable to corrosion, and should be cured at the source, namely in the boiler design.

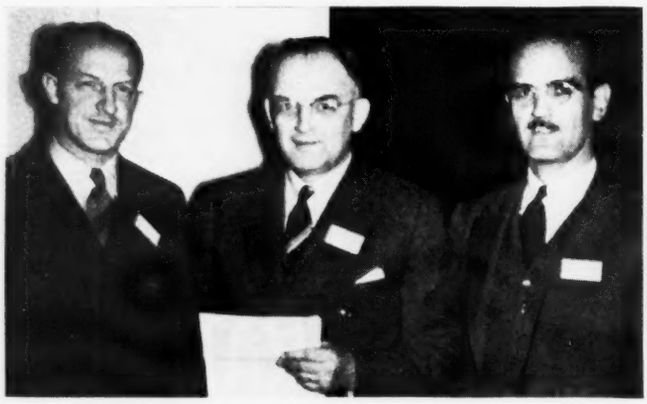
High Pressures

A paper by Wm F Ryan, Stone & Webster Engineering Corp, reported "Progress of Higher Pressures in the Industrial Plant." Only 85 plants now operate in this country at pressures above 500 lb, according to Mr Ryan, and these have a combined capacity (exclusive of Ford's River Rouge) of about 837,000 kw, of which one third is operated by public utilities. No generalization, he said, can be made about ideal pressure for plants supplying industrial steam. In many cases, the approach to the question of pressure has been from the wrong angle; some existing installations might have achieved equal results at less cost by using lower pressure and higher temperature. Reheating, however, holds little promise for the industrial plant.

Nearly three-quarters of the turbines in these plants are for back-pressure operation; even for the others the condensers are small, most of the steam being extracted; only one is non-extraction. Reciprocating engines, once seriously considered, have not made progress in the high-pressure plant.

Feedwater treatment, he emphasized, is a serious problem and a costly one, due to usual high make-up. Reliability, however, has been quite satisfactory, little or no reserve being the rule in industrial plant practice. Such difficulties as have arisen, he added, have been with equipment, water and fuel, rather than with caliber of personnel.

In commenting on the feedwater-treatment problem, S B Applebaum of the Permutit Co stated that excellent results were being obtained with the relatively new hydrogen zeolites in reducing solids content of water and that some experience was being accumulated on the use of magnesium oxide for silica removal. With zeolite softeners now available, solids content can be controlled at will as can alkalinity to stay just far enough above the acid point to provide a margin of insurance against corrosion. Mr Fellows added that painting internal surfaces of the



LEFT—At the session on feedwater (left to right): W B Gurney, Gulf States Utilities Co; C H Fellows, Detroit Edison; E P Partridge, Hall Labs. RIGHT—Somebody told a good story appreciated by (left to right): James W Parker, Detroit Edison; John F Tinsley, Associated Industries of New England; and Prof Charles M Allen, Worcester Polytechnic Institute

WORRY about boiler feedwater trouble won't spoil this chap's trout fishing! His mind is free from care about scale, corrosion and other worries because his plant is protected by the Nalco System of Feedwater Treatment! Nalco offers a complete water treating service. Besides protection for boilers, trouble-making scale formation can be prevented in heaters, economizers, feed lines, pumps, condensers, and other equipment that comes in contact with water. This includes Algae control. Adoption of the Nalco System requires no additional capital investment and total cost may be less than your present expenditures for chemicals alone. Write for complete information today! NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Illinois.

THE NALCO SYSTEM OF FEEDWATER TREATMENT

Inquiries other than domestic *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

Worcester Telegram-Gazette photo

Putting the finishing touches on arrangements for the Hydraulic-Division sessions. Seated, Warren H McBryde, president, ASME. Standing, left to right: Fiske Jones, chairman Worcester Section, ASME; Ralph F Gow, vice-chairman of the general committee; Clarence E Davies, national secretary, ASME; Prof Charles M Allen, head of the Alden Hydraulic Laboratory, Worcester Polytechnic Institute

drum with commercially available coatings also had been found an effective form of added insurance.

Mr Ryan closed with the note of warning that operators of high-pressure plants have to speed up to the new demands of their job. It is worthy of note, he said, that the highest and second highest pressure plants now operating in this country were serving industry. However, temperature has not kept pace with pressure. To insure adequate feedwater treatment every hour of the year, he reiterated, is still a major problem. In a more humorous vein, Mr Ryan suggested that boiler manufacturers would help some by not selling "half-pint" boilers for "four-quart" jobs!

A J German, Scovill Mfg Co, described a new installation now under construction at the Waterbury plant in which design had been centered around night and week-end loads to avoid low-load operation of the turbine as well as frequent starting and stopping. A 650-lb, 750-F operating pressure had been chosen.

An evening session was devoted to fuel burning. G G Martinson of Sinclair Refining Co described the development work on a 3-nozzle, 120-deg-angle, mechanical-atomizing oil burner for heavy cracking-still residue as part of an existing combination burner also suitable for pulverized coal.

Following the paper, several reels of Kodachrome and infra-red motion pictures of oil, gas, pulverized-coal and stoker flames illustrated the mechanism of combustion. Pictures taken at 1000 frames per sec and at one frame per three sec slowed down the turbulence of burner flames and speeded up the action of fuel on stoker beds to give an entirely new and graphic idea of the process of burning.

Government regulation of coal prices, location of an industry with reference to its fuel supply and available competing fuels all tend to make the selection of fuel an engineering problem, according to E W Stone, Bigelow-Sanford Carpet Co. Certainty of fuel supply and cost are the important factors in any production problem.

A paper on "Effect of Coal Characteristics on Pulverized-Coal Firing" was prepared, explained Ollison Craig of Riley Stoker Co, in answer to many requests for a summary of information on suiting the furnace to the coal and vice versa. Carbon loss, excess air and slag are affected by the characteristics of the coal, furnace design, burner and pulverizer construction. Quicker ignition and better flame stability are obtained with high-volatile coal. Other properties of importance are agglutination, swelling, ash content, ash-fusion temperature, moisture, sulphur and grindability.

Recent development in oil burning, particularly burner adaptation to suit wide variations of furnace conditions and fuel oils, were discussed by R C Vroom, Peabody Engineering Corp. Commercial fuel oil, he said, is now usually a product of a cracking still as compared to the straight-run residues available until a few years ago. These fuels have more pounds per gallon, higher heating value per gallon, less heating to obtain required viscosity for burning and a low pour point which assists in handling and storing in winter. Wide range of fluctuating load requires burners that can operate with automatic combustion control without change of atomizer parts or sacrifice of spray quality.

Chairman Engle of Boston Edison commented on the real need for improvement in pulverized-coal burners as exhibited by the motion pictures of the previous evening. He added that one measure of the completeness of combustion he had found satisfactory was the percent combustible in the flue dust.

O F Campbell, Sinclair Refining Co, added that low volatility should not necessarily be a limitation on fuel as he had been successful in burning pulverized petroleum coke of extremely low volatility. This coke is oily so that individual particles adhere in masses after pulverization.

Feed Treatment

A session of specialists on feedwater treatment heard W B Gurney, representing M C Schwartz, T E Crosson and himself, all of Gulf States Utilities, present the results of their measurement of steam purity by weight determination and by spectrographic methods. Solids content of steam of the order of a tenth of a part per million have been consistently verified by both methods. The same authors also presented a detailed procedure for determining ammonia content of condensed steam and for determining the purity of steam by the electrolytic-conductivity method.

At this meeting, L E Hankinson complimented the Hall and Partridge paper on "Attack on Steel in High-Capacity Boilers", presented at the New Orleans meeting a year ago. His experience at Springdale, he said, had borne out the findings and theories advanced by the authors of the original paper to an extraordinary degree. Changing water-supply and steam collection to certain water-wall tubes eliminated tube burnouts. Regarding the decomposition of sodium sulphite, Hankinson added, there is now definite proof of its stability under 1300-lb service. Recirculation of boiler water through the economizer has given complete economizer protection.

Additional papers were: "The New

(Continued on page 134)

WANT THIS KIND OF MOTOR PERFORMANCE IN YOUR PLANT?

Read These Interesting True Case Histories of How Allis-Chalmers Lo-Maintenance Motors are Providing Long-Life . . . Low-Cost Motor Service to Industry!

GET THIS type of up-to-date motor performance in your plant . . . and assure yourself long motor life plus low maintenance . . . with Allis-Chalmers Lo-Maintenance Motors.

For, in Lo-Maintenance Motors, you get such "full-measure" features as—distortionless, twistless stator . . . indestructible, removable rotor . . . high carbon steel frame . . . no skimping anywhere on materials or workmanship!

These are important features . . . designed to give you motor performance that is more than just a rated horsepower. Let the engineer in the district office near you explain them to you. Call him . . . today. Or write Allis-Chalmers, Milwaukee.

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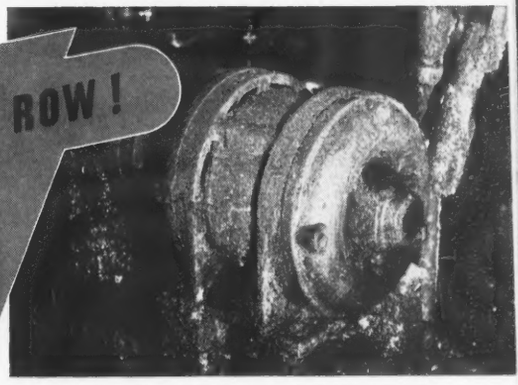
8½ YEAR REPAIR BILL—$000.00!

In this Cincinnati factory, 119 Allis-Chalmers Lo-Maintenance Motors have gone more than 8½ years without one cent spent for repairs . . . typical of Lo-Maintenance money-saving performance.

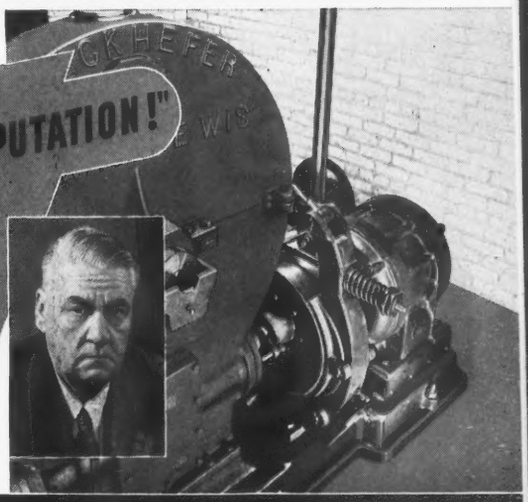
5 YEARS ON SUICIDE ROW!

Not a pretty picture! But this Lo-Maintenance Motor was running perfectly five years after it was installed on "suicide row" in this chemical plant, where adverse operating conditions wrecked other motors in 60 to 90 days!



"HELP PROTECT OUR REPUTATION!"

"Allis-Chalmers Lo-Maintenance Motors help us protect our reputation as builders of elevators that won't break down"—says E. F. Kieckhefer, vice-president, A. Kieckhefer Elevator Company.



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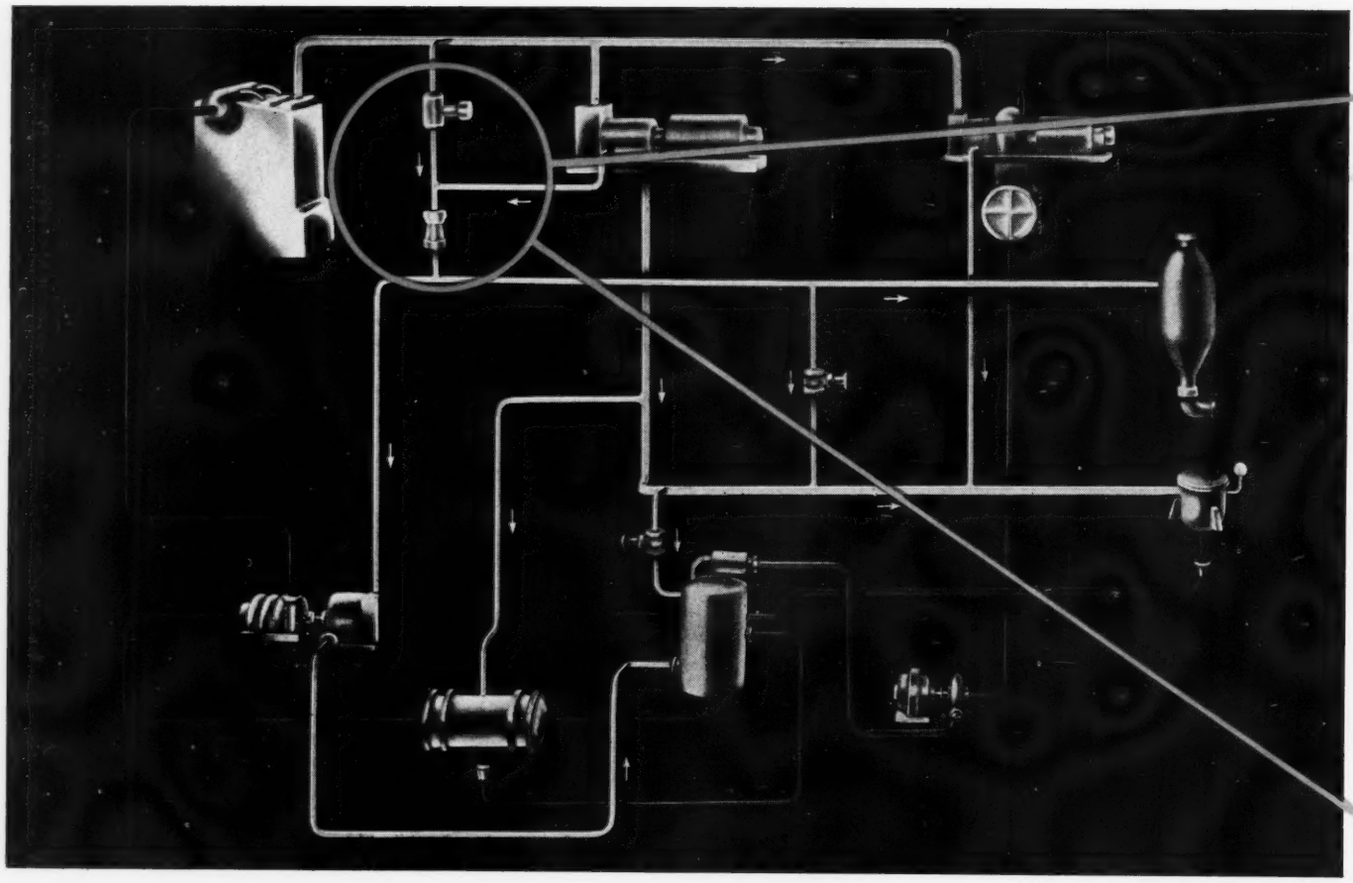
FOR DESUPERHEATER CONNECTIONS...



Courtesy—Power Magazine

HOOKUP #19 **To balance a heavy 1-p process load and a smaller demand for h-p steam, power is generated in this paper mill by both condensing and backpressure turbines. Backpressure-unit bleed supplies h-p process; exhaust combines with bleed from condensing turbine to serve 1-p process. Flexibility is supplemented by reducing stations between pressure levels and by combining steam- and motor-driven auxiliaries. Additional steam for open heater comes from reducing valve.**

BY REDUCING and desuperheating steam, any low pressure, low temperature unit may be supplied from high pressure steam lines.

Simplest method of desuperheating employs the Spray Type unit in which water supply is controlled by the temperature of the steam output. Steam atomizing method shown utilizes a series of integrated control points for use when more accurate final steam temperature is required.

Desuperheater cooling water must be free from solids and supplied at a pressure slightly in excess of low-side steam pressure.

The diagrams shown like all those in the series, are based on accepted good valve usage. We do not presume, however, to make valve-type recommendations. For instance, where a globe or a gate valve may be used, we give Jenkins Figure Numbers for several of each type—you choose whichever suits your needs.

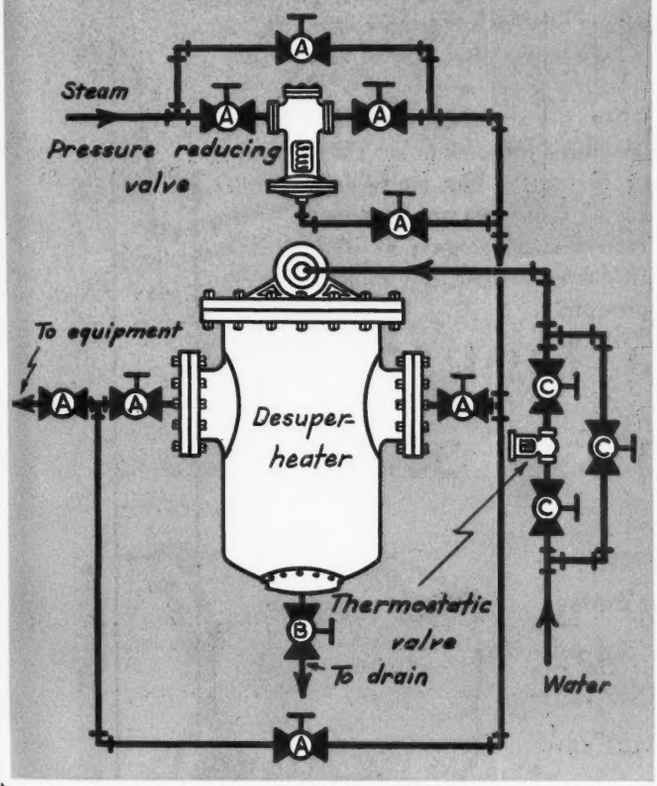
NEXT MONTH—PROCESS WATER TREATMENT

IN VALVES *Jenkins* GIVES YOU EVERYTHIN

. . . TO *GOOD* VALVE PRACTICE

Jenkins RECOMMENDS . . .

STEAM AND WATER
Spray Type Desuperheater

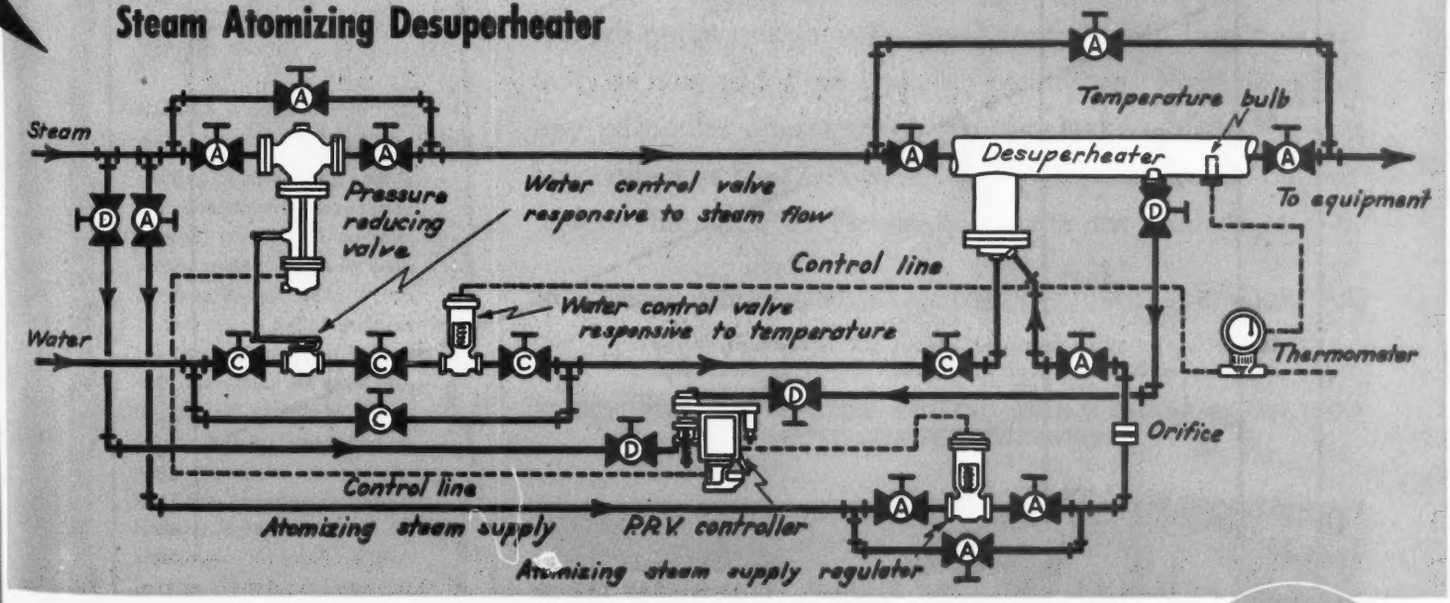


REFERENCE CHART TO JENKINS FIGURE NUMBERS FOR DESUPERHEATER CONNECTIONS

		Standard	Medium	Extra Heavy
A	STEAM SUPPLY GATE	IRON 651 Fl. O.S. & Y.	IRON 253 Fl. O.S. & Y.	IRON 204 Fl. O.S. & Y.
	GLOBE	IRON 142 Fl. Disc Type 913 Fl. Regrinding 613 Fl. Regrinding	IRON 775 Fl. Disc Type 919 Fl. Regrinding	IRON 162 Fl. Disc Type 923 Fl. Regrinding
	ANGLE	IRON 144 Fl. Disc Type 915 Fl. Regrinding 615 Fl. Regrinding	IRON 777 Fl. Disc Type 921 Fl. Regrinding	IRON 163 Fl. Disc Type 925 Fl. Regrinding
B	DRAINS GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr. Renew 956 Sc. Regr.-Renew Plug	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew	BRONZE 970 Sc. Regr.-Renew 982 Sc. Regr.-Renew Bolt Bonn. 976 Sc. Regr.-Renew Plug 988 Sc. Regr.-Renew Bolt. Bonn., Plug
	GATE	BRONZE 47 Sc. Travel. Stem 49 Sc. Travel. Stem 370 Sc. Non-Rising	BRONZE 270 Sc. Non-Rising	BRONZE 280 Sc. Non-Rising
C	WATER LINES GATE	IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S.& Y. 651 Fl. O.S.& Y.	IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
	GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew	BRONZE 970 Sc. Regr.-Renew 982 Sc. Regr.-Renew Bolt Bonn. 976 Sc. Regr.-Renew Plug 988 Sc. Regr.-Renew Bolt. Bonn., Plug
D	CONTROL LINES GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Ren. 956 Sc. Regr.-Ren. Plug	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Ren.	BRONZE 970 Sc. Regr.-Ren. 976 Sc. Regr.-Ren. Plug
	GATE	BRONZE 47 Sc. Travel. Spind. 49 Sc. Travel. Spind. 370 Sc. Non-Rising	BRONZE 270 Sc. Non-Rising	BRONZE 280 Sc. Non-Rising
	GLOBE NEEDLE	BRONZE 743 Sc. Needle 741 Sc. Needle	BRONZE 743 Sc. Needle 741 Sc. Needle	BRONZE 703 Sc. Needle 705 Sc. Needle

Motor-operated Iron and Steel Valves can be supplied.

Steam Atomizing Desuperheater



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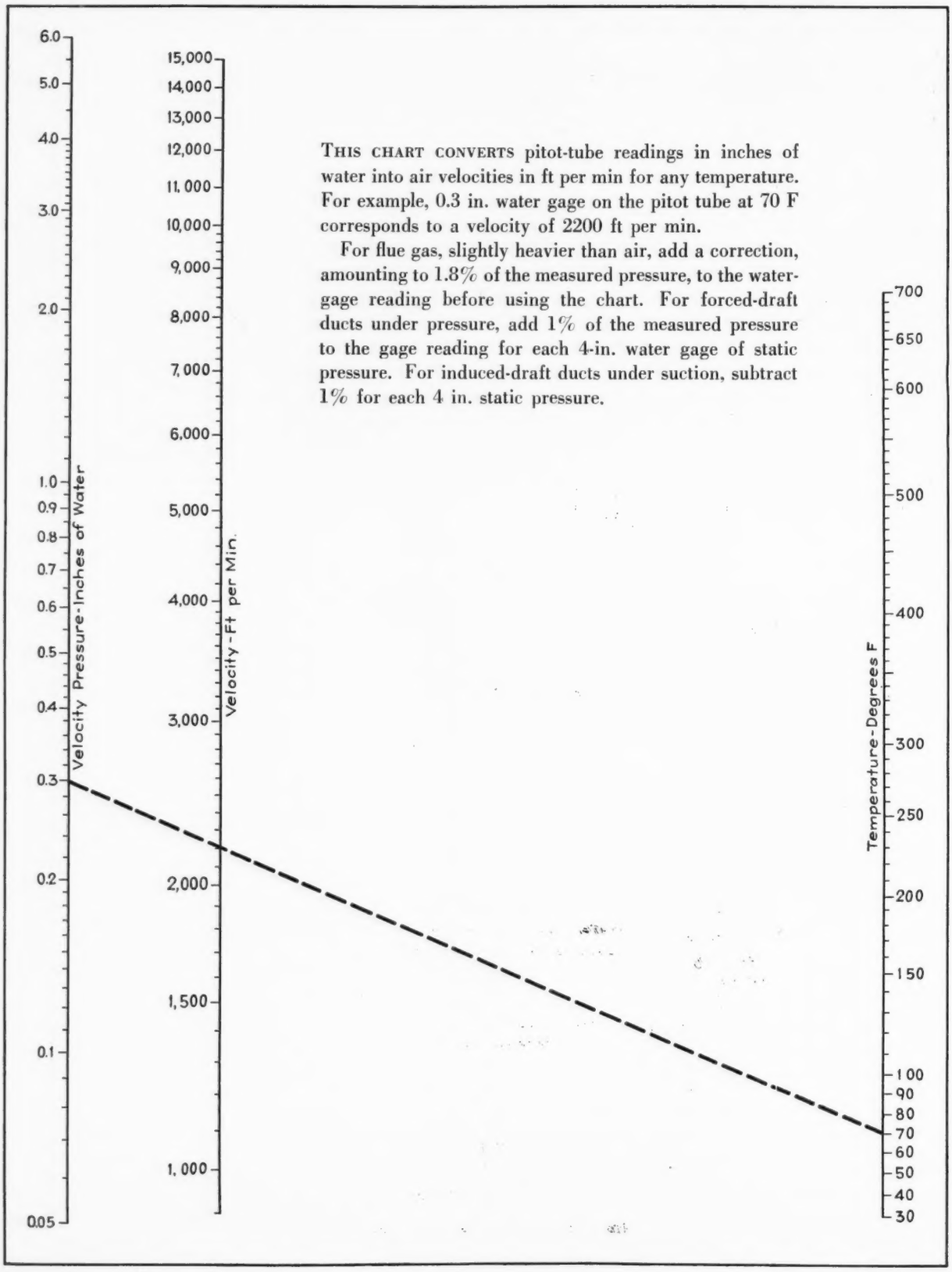
#19 OF A SERIES designed to help in your selection of JENKINS VALVES

Number 95

Velocity Pressures by Pitot Tube



THIS CHART CONVERTS pitot-tube readings in inches of water into air velocities in ft per min for any temperature. For example, 0.3 in. water gage on the pitot tube at 70 F corresponds to a velocity of 2200 ft per min.

For flue gas, slightly heavier than air, add a correction, amounting to 1.8% of the measured pressure, to the water-gage reading before using the chart. For forced-draft ducts under pressure, add 1% of the measured pressure to the gage reading for each 4-in. water gage of static pressure. For induced-draft ducts under suction, subtract 1% for each 4 in. static pressure.

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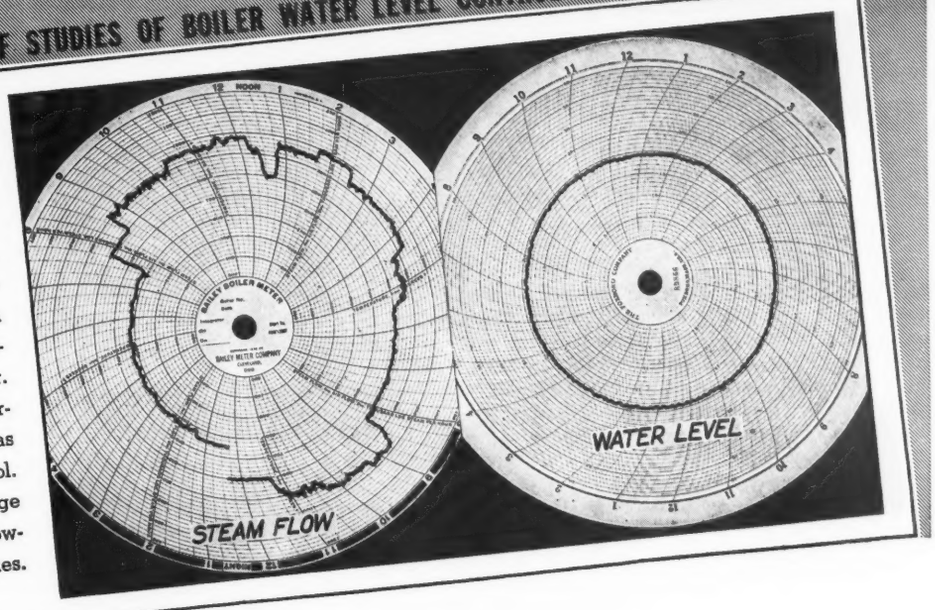
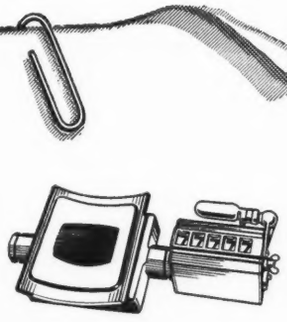
NO. 5 IN A SERIES OF STUDIES OF BOILER WATER LEVEL CONTROL WITH COPES FLOWMATIC

875 POUNDS W. S. P.

Powdered coal firing. 875-lb. 860-deg. Foster Wheeler 3-drum boiler. (Plant name on request). Maximum evaporation, 400,000 lb. per hour. Normal, 330,000 lb. Motor-driven centrifugal pump has no automatic pressure control. Extreme water level range permitted by COPES Flowmatic Regulator is 1.6 inches.



★ 5 plants in this utility system are getting control like this



COPES COAL COUNTER

Gives accurate, continuous reading of how much coal is fed each stoker. Inexpensive to buy, install and operate. Large lighted dial easily read 30 feet away. Only a soft rubber roller, highly resistant to abrasion, comes in contact with the coal. Measurement continues accurate much longer than if it depended on any wearing part in, or touching, the abrasive material. Nothing to stick or break off and cause "bridging" of coal in pipe. Write for Bulletin 411.

Promises might sell a first order, but no progressive utility system repeats with any equipment until it has made good on the job. And the COPES Flowmatic Regulator has done just that with this system. Since 1937, when its first Flowmatic was installed, five plants have bought this simplified steam flow type feed water regulator for new 875-pound boilers. All are getting close water level control, with feed flow exactly as needed for the steaming conditions. None have had any particular operating or maintenance problems. If you want effective feed and level control on your modern boilers, specify the COPES Flowmatic. Write for Bulletin 409-B.

NORTHERN EQUIPMENT CO., 601 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY AND ITALY
REPRESENTATIVES EVERYWHERE

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR

COPES — FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

ENGINEERS' BOOKSHELF

Induction Motors

INDUCTION MOTORS (1939). *By S Gordon Monk, Head of Electrical Engineering Department, Plymouth and Devonport College. Distributed by Chemical Publishing Co, Inc, 148 Lafayette St, New York, N. Y. 126 pages, 6x8½ in., illustrated, fabroid binding. Price $2.00.*

Fundamental principles, characteristics and application of induction motors are set forth in this book. It is written more along the lines of a college text than a book for practical electrical workers. Mathematics and the circle diagram have been used quite freely, but several of the chapters are easy to read.

The book is divided into 10 chapters: introduction, torque properties, testing and equivalent circuits, the circle diagram, the single-phase motor, the synchronous-induction motor, methods of starting induction motors, speed control of induction motors, power-factor improvement of induction motors and design of induction motors. At the end of each chapter a number of problems are given with the answers in the back of the book. This feature makes the book well adapted for home study.

Training

TRAINING PROCEDURE (First Edition, 1940). *By Frank Cushman, Consultant in Vocational Education, Federal Security Agency. Published by John Wiley & Sons, Inc, New York. 230 pages, 5½ x 7¾ in. Price $2.00.*

After years of practical cooperation with industrial and business executives, supervisors and foremen, Mr. Cushman here lays down the essentials of an efficient training program in an industrial, business or public-service organization. The aim of such training, as the author sees it, is better work, rather than "adult education". Subjects discussed include: (1) Problems of Training Employed Personnel, (2) Identification of Need and Preliminary Planning, (3) Organization of Training, (4) The Operating or Putting-Over Stage, (5) Checking the Outcomes of the Training Program, (6) The Application or Training Stage, (7) The Holding-On or Maintenance Stage.

Appendices give outline of courses for training instructors and conference leaders.

Electric Wiring

THE SIMPLEX WIRING MANUAL (1940). *Published by the Simplex Wire & Cable Co, 79 Sydney Street, Cambridge, Mass. 270 pages, 4x7 in., fabroid binding. Free.*

This book is not a catalog, but a handbook of tables and data for electrical engineers, contractors and electricians. The many tables give data on most every phase of electric-wire and cable applications. These are arranged under these headings: bare wire, rubber-insulated cables, plastic insulation, varnished-cambric insulation, impregnated-paper insulated cables, series-lighting cables, current-carrying capacity and cable-engineering data.

The latter includes 25 items, such as definitions of cable terms, capacitance and inductance of cables, insulation resistance, dielectric loss, selection of cables, formulas for line current and voltage loss, overload calculations, fault location, etc. The material is presented in a practical and easily used form so that the book is useful to every one interested in wire and cable problems.

Power Distribution

ELECTRIC DISTRIBUTION FUNDAMENTALS (1940). *By Frank Sanford, Distribution Engineer, Cincinnati Gas & Electric Co. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y., 242 pages, 6x9 in., 158 illustrations, 17 tables, cloth binding. Price $2.50.*

Written for the men on the job, this book deals with power distribution problems as found in both utility and industrial systems. The subject is approached from the fundamental viewpoint and the economic background of electric distribution developed as a part of the general system of electric supply. The text is divided into 16 chapters: perspective of the electric system, distribution to serve the load, the distribution division, generation of electricity, fundamentals of electric circuit, inductance and related characteristics, tools for electric problems, transformers, transformer connections, voltage control, circuit-interrupting equipment, voltage protection, lightning grounding, street-lighting circuits, mechanical principles in distribution, economic principles in distribution, measures of service, and appendix.

Graphic methods of solution are used for typical problems of line design. Essential theory is explained largely by means of comparison and analogy, thus avoiding mathematics wherever possible. However, there are included many problems that require a working knowledge of voltage drop, wire-size calculation, transformer connections, power factor, etc.

Surveys

INDUSTRIAL SURVEYS AND REPORTS (1940). *By Walter Rautenstrauch, Professor of Industrial Engineering, Columbia University. Published by John Wiley & Sons, Inc, 440 4th Ave, New York, N. Y. 189 pages, 6x9 in., cloth binding. Price $2.50.*

This book does not cover the "composition" of reports; it discusses the technical content of engineering reports and the problems encountered in investigating and reporting on industrial operations. Starting with general principles of what constitutes a good report, the author discusses the nature of industrial surveys and reports for financing purposes. The following chapters cover specific phases of such reports, including the technical and economic aspects of the business, business and financial policies of the company, organization and personnel, patents and goodwill, labor conditions, sales policies and methods, physical equipment, and analysis of financial statements.

Appendices include a typical report, a code for graphic presentation, financial calculations frequently used in industrial surveys, and a summary of formulas used in estimating the economic characteristics of a business enterprise. A number of problems involving field investigation are included.

Engineering History

INVENTORS AND ENGINEERS OF OLD NEW HAVEN (1939). *Edited by Richard Shelton Kirby. Published by the New Haven Colony Historical Society, New Haven, Conn. 111 pages, 6x9 in., cloth binding.*

Anyone interested in engineering history will find this little book fascinating reading. From a series of six lectures, delivered at Yale University as a prelude to the New Haven Tercentenary Celebration of 1938, comes an entirely new picture of the importance of New Haven in America's industrial past.

Not only was it the home and work place of such men as Eli Whitney, pioneer in interchangeable manufacture; Ithiel Town, inventor of the lattice truss; Charles Goodyear, discoverer of vulcanization of rubber; David Bushnell, originator of the submarine and torpedo; Samuel F B Morse, inventor of the telegraph; Eli Whitney Blake, whose stonebreaker made possible cheap highways and reinforced concrete; Alexander Catlin Twining, railroad and water-supply engineer; Henry Farnam, famed railroad builder; and Henry Law Olmsted, pioneer landscape architect; but the enterprise and progressive quality of its citizens made it a leader in development of public utilities of all kinds—gas lighting, water supply, street railways, telephones and electric light.

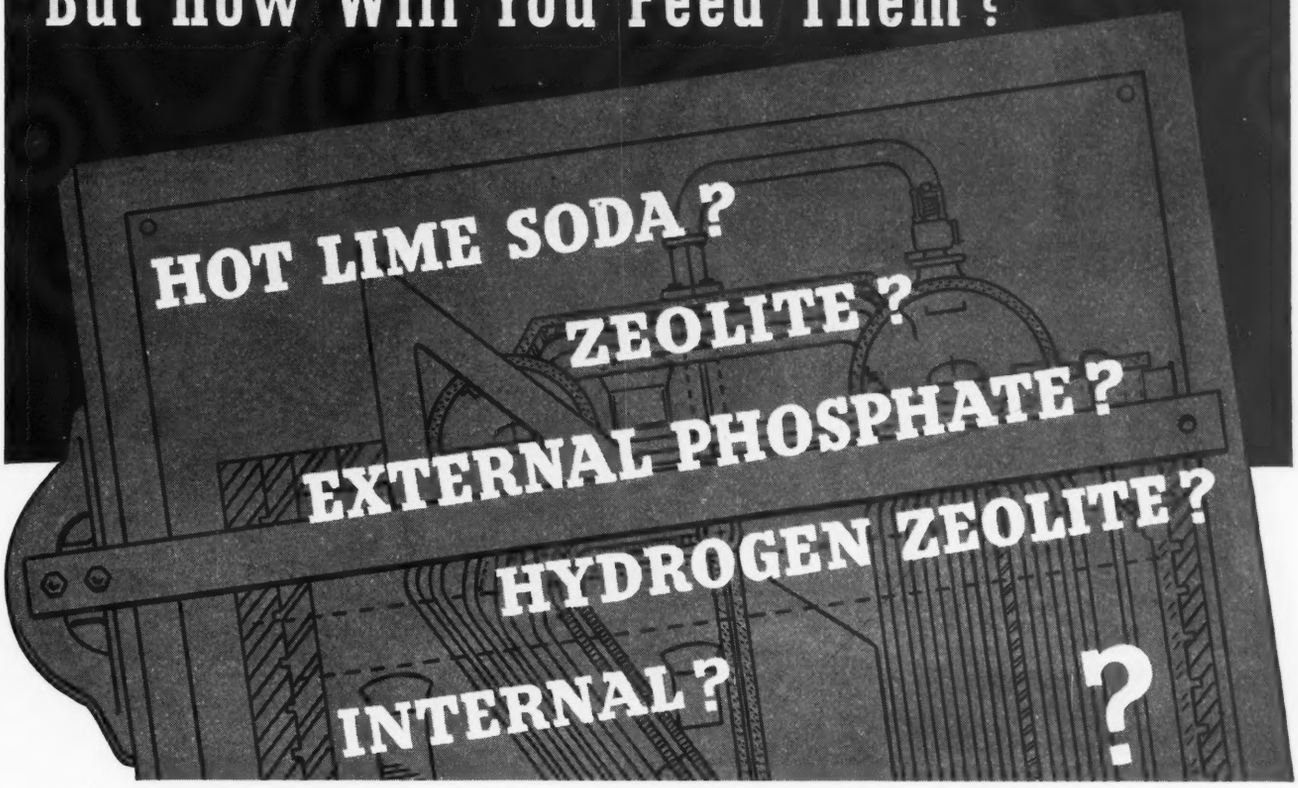
Electricity

PRACTICAL ELECTRICITY (4th Edition——1940). *By Terrell Croft. Revised by George H Hall. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 701 pages. 5½x8 in., 599 illustrations, cloth binding. Price $3.00.*

Published 17 years ago, this popular book on electricity and magnetism has withstood the ravages of our rapidly changing times and is now in its 4th edition. The book begins with a chapter on matter and the electron theory and covers practically all the ramifications of electricity, magnetism, direct and alternating-current equipment in 54 chapters and an appendix. The presentation is practical and the 600 illustrations do much to make the text easily understood by those with limited technical knowledge.

(Continued on page 158)

NEW BOILERS ON THE BOARDS · · ·
But How Will You Feed Them?



Let us professionally review your boiler specifications to see if they are consistent with your water supply.

Let us plan your water correction —select the best and most economical methods or materials to suit your conditions.

Because we do not sell equipment, our selection is made with unbiased judgment from all the offerings of all the manufacturers, with only your complete satisfaction in mind.

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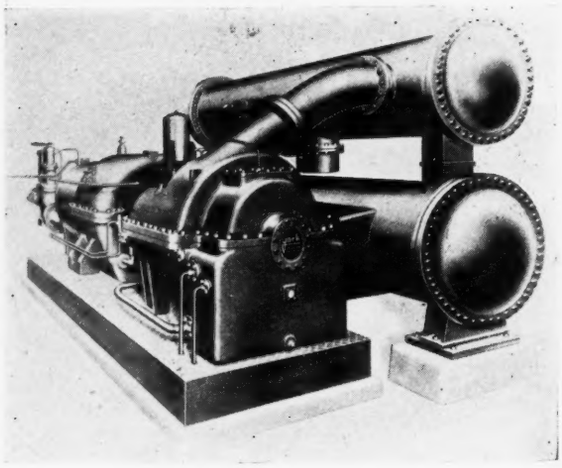
Chemical Engineers and Consultants on All Water Problems

WHAT'S NEW IN PLANT EQUIPMENT



Refrigeration Turbo-Compressor

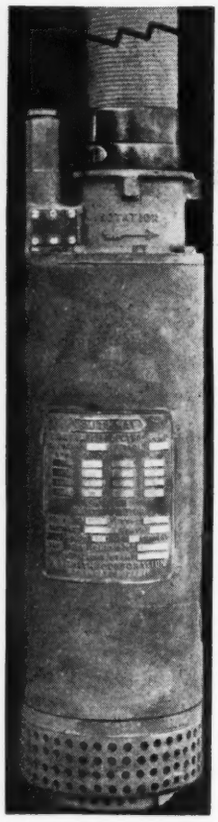
NEW LINE of refrigerating turbo-compressors marks entrance of company into this field of equipment to supplement its line of vertical reciprocating compressors, particularly in places where steam-turbine drive can be efficiently applied. Turbo-compressor can also be motor driven. Standard systems available range from 150 to 1000 tons of refrigeration. Applications will include large air-conditioning systems for comfort or process—also water- or brine-cooling systems for manufacturing plants. Refrigerant is trichloro-monofluoro-methane or "Freon-11". Turbo-compressor is said to be so free from vibration that it can be mounted on upper floors or light foundations. Features include impellers operating at low speed, "balance-disk" compensation of impeller thrust, and bladeless diffuser vanes for reducing pumping limit. Condensers are of non-ferrous internal construction. Accompanying water-cooler is of flash-type, non-ferrous construction, with hermetically-sealed liquid pumps. With steam-turbine drive, refrigeration is controlled by turbine speed.

York Ice Machinery Corp, York, Pa.

Auxiliary Switch

ELECTRICALLY-OPERATED switch is used for making and breaking several circuits simultaneously, such as on a differential bus protection system, where several circuit breakers are tripped at once. Two operating arrangements are provided as standard. One type can be tripped from the front of the panel by rotating the handle, as well as by energizing the shunt trip coil. Other type can be tripped only by the operating mechanism behind the panel. Position of the handle shows last switch operation.

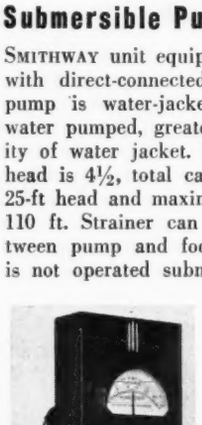
Westinghouse Elect & Mfg Co, East Pittsburgh, Pa.



Submersible Pump (above)

SMITHWAY unit equipped for submergence with direct-connected strainer. Motor in pump is water-jacketed and thus, more water pumped, greater the cooling capacity of water jacket. Maximum hp at any head is 4½, total capacity is 220 gals at 25-ft head and maximum pressure head is 110 ft. Strainer can be interchanged between pump and foot valve, when pump is not operated submerged.

Sawyer Electrical Mfg Co, 5715 East Leneve St, Los Angeles, Calif.



Register, Indicator and Recorder (below, left)

TYPE M series is latest model of first unit brought out about 25 years ago. At rear of register two large mercury wells, connected at the bottom, forming a U-tube, receive the differential pressures, either direct or by air-relay transmission through usual small pipes from inlet and throat. On one of mercury columns rest solid metal float of large diameter which provides actuating force responsive to minute variations in mercury levels. Through a positive rack-and-gear transmission, float-movement determines position of rate-indicator-dial hand, chart pen, and driving roller of totalizer. Working parts are balanced and entire mechanism mounted in same metal frame. Corrosion-resisting metals are employed for shafts, bearings, and other working parts.

Builders Iron Foundry, 7 Codding Street, Providence, R.I.

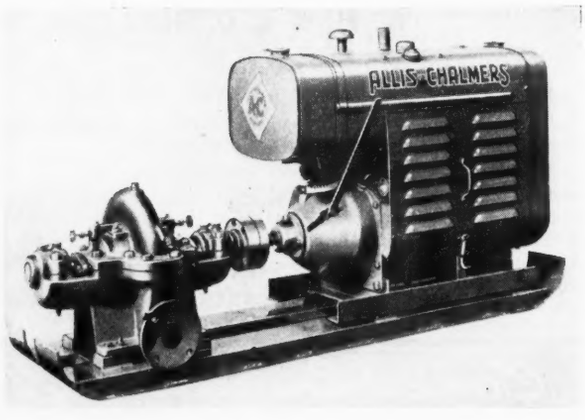
Steel Valves

NEW LINE of valves consists of gate, globe, angle, and check. Gate valves are cast steel, globe and angle valves are forged steel in two types; and check valves in two types, horizontal pattern being of forged steel and vertical pattern of cast steel.

Crane Co, Chicago, Ill.

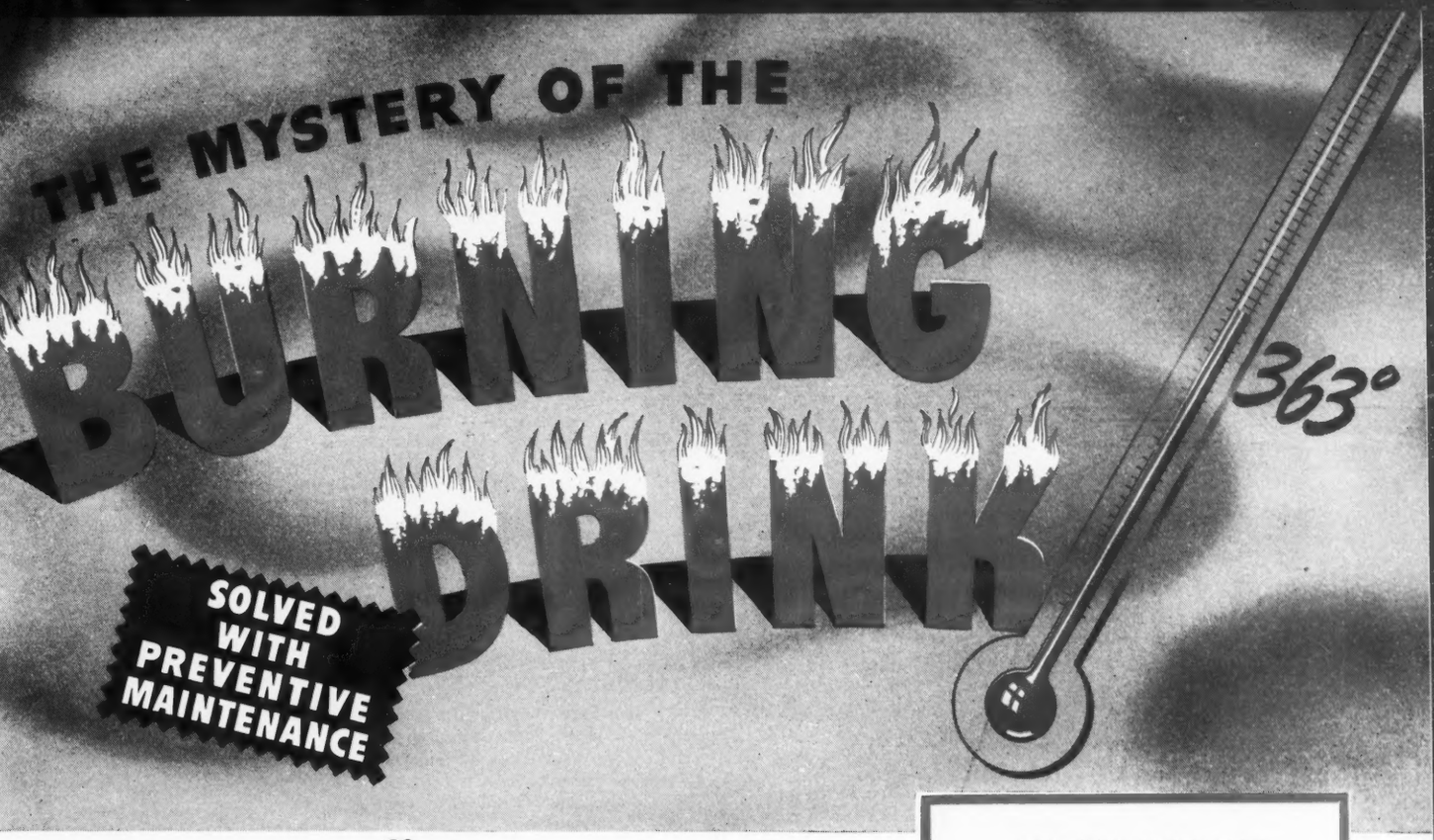
Engine-Driven Centrifugal Pump

PROVIDING independently-powered pumps for drainage, coal-washing, etc, units are used mainly for standby when other sources of power fail. Power units in 5 sizes available from 18 to 110 hp, operating on gasoline, kerosene, distillate, natural-gas or butane. All power units have valve-in-head medium-speed engines with removable cylinder liners, force-feed lubrication and a variable-speed governor. Centrifugal pumps are horizontal-shaft, single-stage, single- or double-suction, designed to handle liquids at normal temperatures. Both engine and pump are



THE MYSTERY OF THE BURNING DRINK

SOLVED WITH PREVENTIVE MAINTENANCE



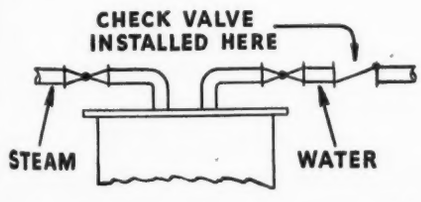
"Accidents like this can cost us a fortune," excitedly shouted the PLANT SUPERINTENDENT.

"How in blazes did steam get into that drinking fountain," woefully spoke the MAINTENANCE FOREMAN.

"But it won't happen again," assured the CRANE MAN. "Preventive Maintenance will see to that."

IN a midwestern manufacturing plant one day, a worker left his post to get a drink. He wanted a cool drink; for a few moments he let the water run. But, as he stooped to drink, instead of refreshing water, from the fountain there came a blast of burning, blinding steam.

In another department, silicate of soda used for processing was melted by running steam through a coil in the large vat. The liquid was then cooled by running cold water through the same coil. A globe valve in each line controlled the steam and water, the water connection coming direct from a 2½-inch main line which supplied the entire building.



A batch of the processing material had just been melted and was ready for cooling. The water valve was opened wide. But, the operator forgot to close the steam valve. Then the trouble started: 160-pound steam easily forced its way into the water line. And it was the thirsty workman who provided an outlet for the angry steam.

"This must never happen again," said the Superintendent. A warning to the vat handlers wasn't enough; he wanted the danger totally eliminated. So he called in W. F. C., the Crane Man, who suggested Preventive Maintenance. The solution to the problem was simple, yet Preventive Maintenance would safely guard against recurrence. It counseled the installation of a Crane No. 74E Brass Check Valve in the water line to the processing vat.

Results: (1) The trouble was permanently remedied. (2) The management has peace of mind about the safety of its employees from this danger. (3) Another manufacturer has learned the sound economy of Preventive Maintenance. Has learned, too, to look to Crane for the valves and fittings for the most economical solution to every piping problem. And, he knows it pays to consult the Crane Representative—always.

This case is based on an actual experience of a Crane Representative in our Kansas City Branch.

CHECK VALVES ARE "TRAFFIC COPS" IN PIPE LINES

In industry there are few piping systems, if any, in which backflow is not dangerous or damaging. Thus check valves are often the most essential valves in a line. They police your piping—keep flow going in the right direction.

Systems lacking adequate backflow control afford the Plant Engineer a valuable opportunity to apply Preventive Maintenance now—before costly damage results to product or equipment, or harm to personnel. To meet the varying operating conditions of industrial piping, Crane makes check valves in a complete range of designs and materials—for all working pressures.

You'll get a lot of satisfaction in Crane No. 74E Brass Check Valves. They're rated at 300 pounds steam, 550°, and are built to give superior service. For steam, water, oil or gas lines, they're an outstanding buy. Consult your Crane Representative.

1940 85th YEAR

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VALVES • FITTINGS • PIPE
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NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

mounted on base and are available in combinations to meet requirements in quantity and pressure up to 5000 gpm, and 100 ft head.

Tractor Div, Allis-Chalmers Mfg Co, Milwaukee, Wis.

Automatic Lubricator

SIMPLEX lubricator replaces oil cups and grease fittings on machinery of many kinds. Lubricator is essentially a spherical steel shell with grease fitting and $\frac{1}{8}$-in. pipe thread connection for insertion in bearing hole or suitable adapter. Inside steel shell is hollow Neoprene ball and outlet channel that prevents ball from clogging outlet. When grease or fluid oil is forced into fitting with conventional equipment, internal pressure may rise momentarily to 1500 lb psi. This pressure collapses ball and compresses air in it, thus storing energy for feeding lubricant to bearing. Resistance of bearing may be only 160 lb psi, and thus ball expands and flushes lubricant through bearing until internal pressure equals bearing resistance. Under these conditions some 120 drops of lubricant may remain in reservoir.

Simplex Mfg Co, 1504 Broadway, Detroit, Mich.

Packaged Synchronous Motor

HIGH-SPEED synchronous motor consists of fabricated, all-steel motor, exciter mounted on top of and V-belt-driven by the motor, and field control unit, mounted on motor, for automatically applying and removing excitation for field winding of synchronous motor. Exciter and field-control unit are wired to motor at factory, leaving to be done on the job only wiring between synchronous motor and line control unit, which can be ordinary across-the-line or compensator-type induction-motor starter. Units available up to 350 hp at 1800 rpm.

Electric Machinery Mfg Co, 1331 Tyler St, N.E., Minneapolis, Minn.

Wick-Feed Oiler

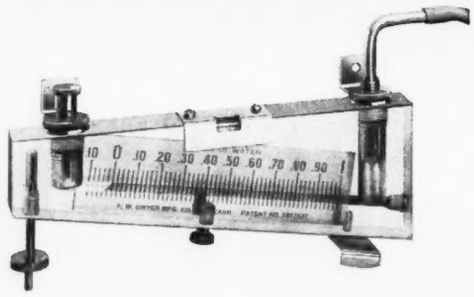
TRICO oiler is intended for use on machinery which operates intermittently. Lever at top, when in vertical position, starts feed, and when flipped to the side, shuts off feed. When oiler is filled above point where wick enters center tube, surplus oil drains into bearings, flushing them. When oil recedes to tube opening, wick automatically feeds oil to the bearing by capillary action. Available in sizes from 1 to 4 ounces.

Trico Fuse Mfg Co, 2948 N 5th St, Milwaukee, Wis.

Asbestos-Insulated Duct

IMPROVED CAREYDUCT is made in standard double-layer sections, consisting of an inner layer or core about $\frac{3}{16}$-in. thick of asbestos. Over this core, making a close, sliding fit, is outer shell or insulating jacket made of corrugated asbestos bonded to form a substantial structure and give high insulating value. Total wall thickness of core and jacket combined can be made from one-half inch up, depending on requirements.

Philip Carey Co, Lockland, Cincinnati, Ohio



Portable Draft Gage

TRANSPARENT gage measures draft, air velocity and slight pressure variations. Indicating tube and oil chambers are drilled and reamed in solid block of clear transparent plastic. This is said to insure polished uniform bores and eliminate strain between parts. Clean-out connection provided for swabbing out indicating tube. Only glass part is leveling bubble, which is well protected. Scale graduations extend full five inches, with more than an inch of sliding adjustment, and scale is held under spring tension.

F W Dwyer Mfg Co, 565 W Washington Blvd, Chicago, Ill.

Non-Slip Paint

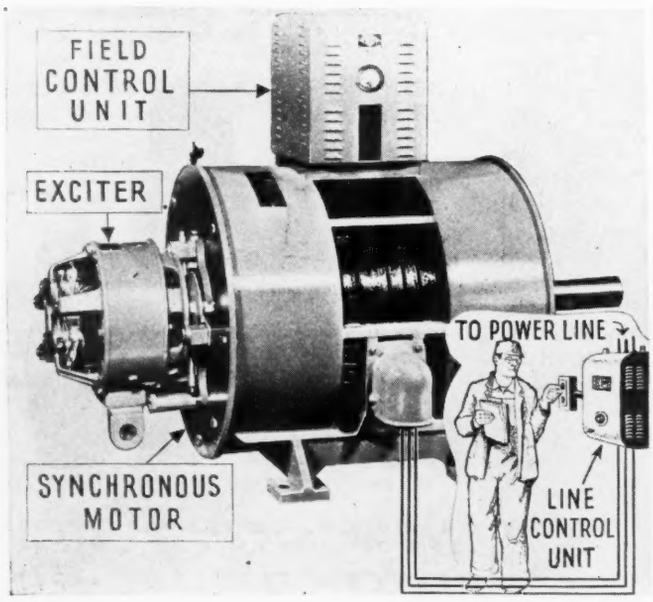
SAFE-T-STEP is paint with rubber base combined with abrasives for taking skid out of all types of floors. Manufacturer claims surface covered with coating is not slippery even when wet or oil-splashed. Requires no special preparation of floor aside from ordinary care and having the surface clean, dry and free from oil at time of application.

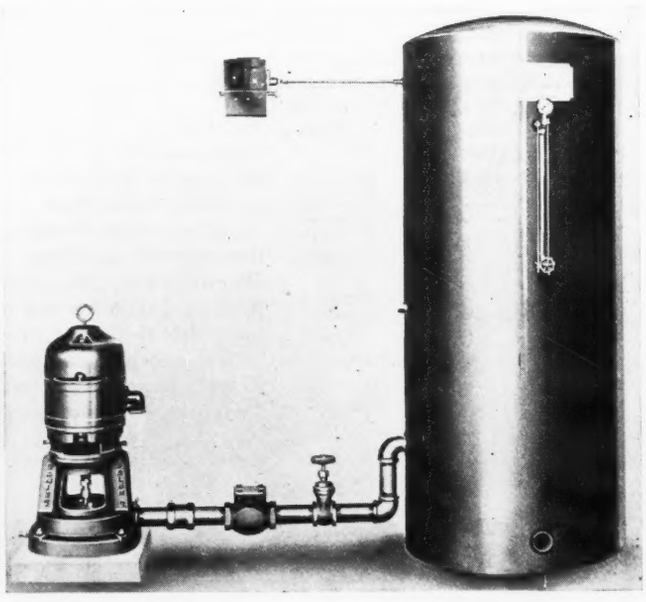
Truscon Laboratories, Detroit, Mich.

Turbine Pumps (below)

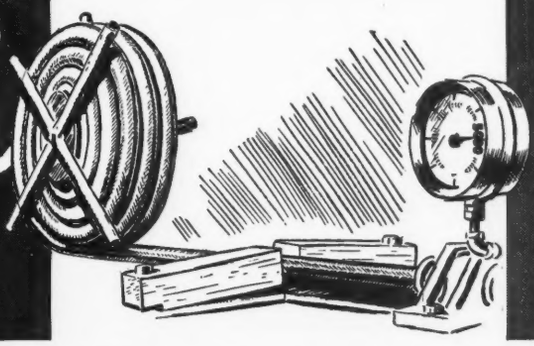
MINUTURB deep well turbine pumps utilize vertical solid-shaft motor coupled to stainless-steel stuffing-box shaft by adjustable coupling. Bowl assemblies are built with

(Continued on page 140)



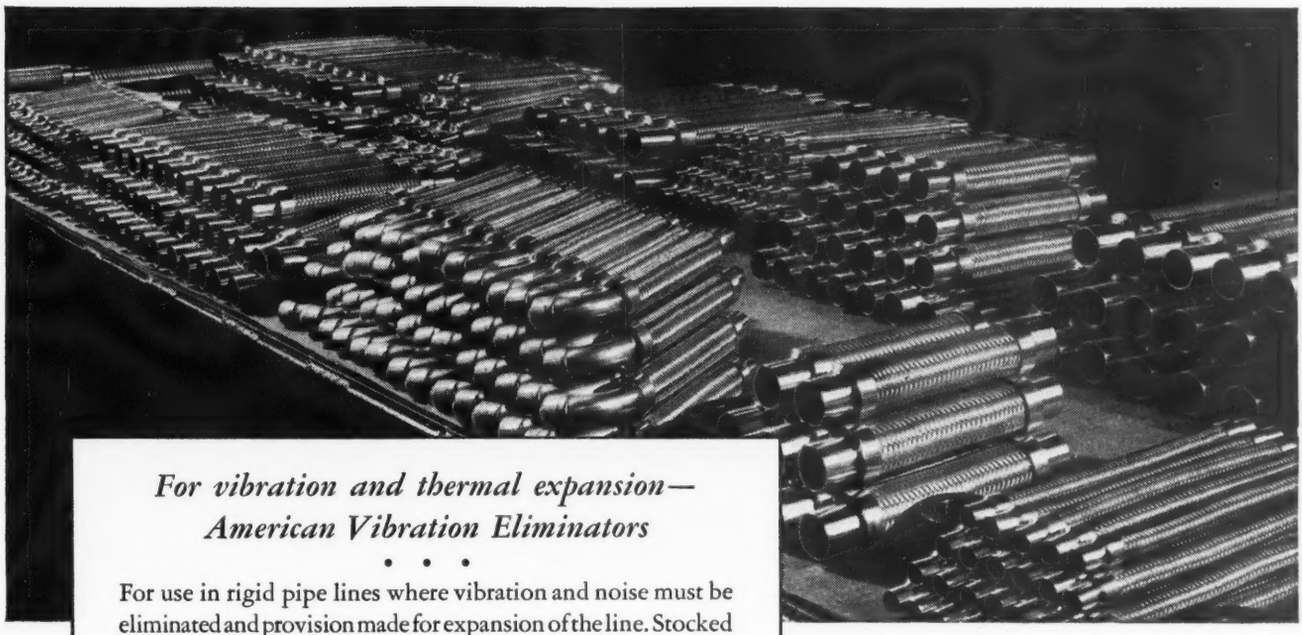


AS FLEXIBLE AS
Garden Hose



AS STRONG AS
RIGID PIPE

AMERICAN SEAMLESS!



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American Vibration Eliminators

• • •

For use in rigid pipe lines where vibration and noise must be eliminated and provision made for expansion of the line. Stocked as complete units for immediate shipment. Sizes up to 3″ I. D.

THOUSANDS of installations have proved that American Seamless is the most effective answer where constant flexing, permanent and complete tightness, expansion or vibration are important considerations. Why?...

Because it has no welds, joints, laps, seams or packing and is as tight for the conveying of air, gas, steam and fluids as the rigid seamless tube from which it is made... because it can be used under any temperatures up to the point where the heat will affect the physical structure of the metal itself... because it withstands high pressures (½″ I. D. with two braids has a hydrostatic bursting pressure of 5000 lbs. per sq. in.)...because in several different types of installations, American Seamless has flexed millions of times without breaking.

Benefit by these exclusive advantages. Solve your next flexible connector problem with American Seamless. A complete catalog, SS-25, is yours for the asking. 40240

American Metal Hose

ANACONDA
from mine to consumer

AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Conn. • Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Dynamos for Lightning Bugs . . .

MY SON BILL was trying to decide between going to work for me and going on to college. Said he, "Dad, why should I put in four years studying engineering? You didn't, and you haven't done so badly. An' besides, what can I use it all for when I get done? Lots of college graduates haven't got jobs right now, an' you've said time and time again that power engineering nowadays is just pushing buttons and reading gages."

"Look, Kid," I said, "I don't want to push you one way or the other—I just want to offer you the chance I never had. I know you want a car and money in your pocket. Every boy your age does. And there *are* lots of college graduates out of jobs. But you wouldn't have to be one. If you learn all you can in those four years, you'll have just that much better chance when you get through. Remember that a lot of fellows that never went to college are out of jobs too—with a lot less to offer in case a job turns up. And don't worry about power engineering being so simple; that's just one of my bum jokes. As long as we throw away over two-thirds of the fuel we burn, even in our best engines, there's still plenty to be done!

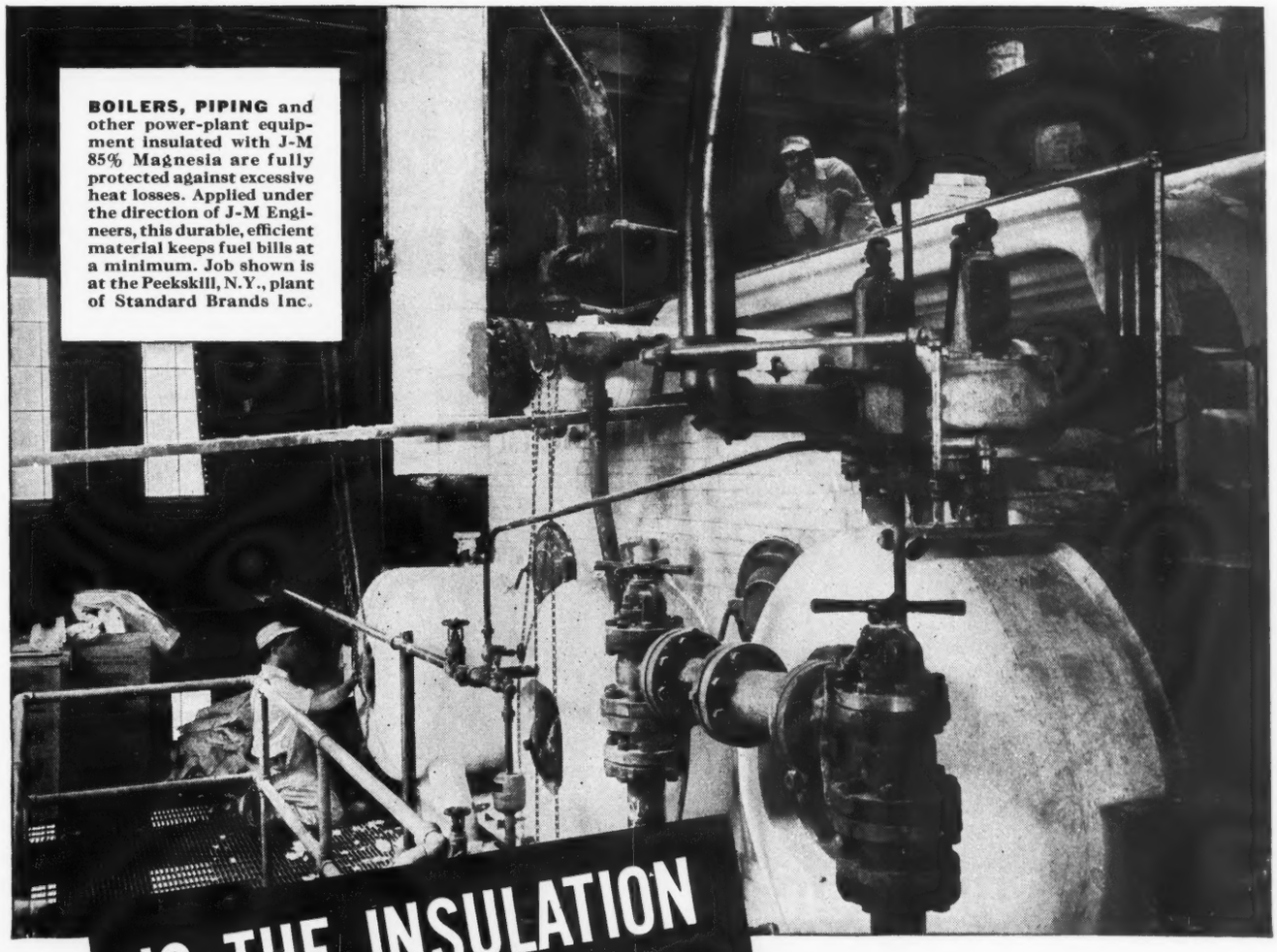
"Let me tell you something I just read: We brag about electricity and the electric light, but do you know that the mazda bulb isn't any more efficient than a good turbine or a diesel? The mazda converts 25 to 35% of the power it uses into light rays; the rest gets lost as heat. Sure, that's 25 or 35 times as good as the candle, but it's still peanuts.

"You've heard me joke about building dynamos for lightning bugs. Well, let me tell you—I wish I could build one! A lightning bug produces 92 to 100% light rays from the fuel he burns—three times as good as we can do! What's more, he makes his own fuel, which the scientists call *luciferin*—which is all we know about it. He packs it in little combustion cells, each one a little transparent boiler, and it burns when he wants it to—when he sucks in air for combustion. And back of each little boiler is a reflecting cell that directs the light where he wants it to go. Yessir, there's a lot of engineering in a lightning bug's tail. Maybe you could put in four years very profitably learning how he does it!"

Two weeks ago I sat in the audience while Bill got his diploma. And after it was over, he came down to me and said, "Well, Dad, did you see the title of my thesis in the list? It's 'Characteristics of the Fluorescent Tube'—you see, I'm still chasing after the lightning bug's dynamo. The fluorescent is half again as good as the mazda you talked about four years ago—50% of the power it uses is converted to light. We're already half as good as the lightning bug—and I'm going to work at Nela Park to see if I can't help catch up with him!—And incidentally, Pop, I've done some studying of your friend the lightning bug, who for all his efficiency is a bit of a dope. Even us college kids know enough to turn the lights out to attract the ladies—but the lightning bug turns his on!"

George Edwards

Engineer



BOILERS, PIPING and other power-plant equipment insulated with J-M 85% Magnesia are fully protected against excessive heat losses. Applied under the direction of J-M Engineers, this durable, efficient material keeps fuel bills at a minimum. Job shown is at the Peekskill, N.Y., plant of Standard Brands Inc.

IS THE INSULATION IN YOUR PLANT ONLY HALF RIGHT?

ALMOST any insulation will save you some money on fuel. But to get fuel costs down to rock bottom . . . and to keep them there . . . it takes the *one correct insulating material*, applied in the *one most economical thickness*.

To assure every saving possible with insulation, leading power plants rely on the J-M Insulation-Engineering Service. J-M Engineers bring to your plant specialized technical experience and training that enable them to trace down sources of costly heat loss that might otherwise go unnoticed. Because they work with the complete J-M line of insulations, they can recommend the exact amount of the right insulation for your particular problem . . . help you make sure that your insulation investment pays maximum returns.

Whether you are planning on installing new power-plant equipment or interested only in checking heat economy on existing equipment, it will pay you to investigate this free J-M service. For complete information and data on all J-M Industrial Insulations, write for Catalog IN-55A. Johns-Manville, 22 East 40th Street, New York, N. Y.

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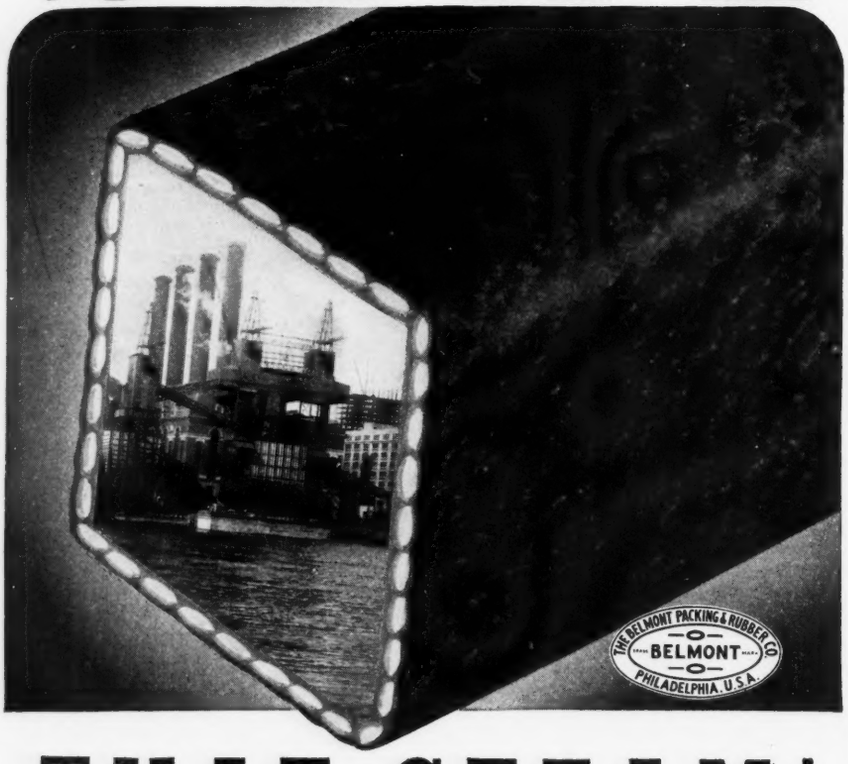
SEAL



THAT STEAM!

PACK WITH BELMONT

Keep your pressure! Use a packing designed for high pressure steam service.

The packing illustrated above, Belmont 30, offers a unique center construction. Center block is pleated upon itself, accordion fashion, at an angle of approximately 90 degrees with the rod. This provides high resiliency—abundance of take-up on the gland, and ultimate "edge wear" (longer life) on the block.

All Belmont packings are constructed to give maximum economical service under the most rigorous conditions. No matter for what service you buy a Belmont packing, you'll find it made with the same fine care and attention to detail that distinguishes Belmont 30. See the complete line of Belmont packings in the new 1940 catalog. A request on your company letterhead brings it absolutely FREE.

Suggested Belmont Packings For Steam Service

BELMONT 30

High Pressure Packing. Made of closely woven asbestos cloth frictioned with a heat-resisting rubber compound. Unique accordion-pleated center block. Rubber cushion remains resilient even under extreme temperatures. Comes lubricated and graphited unless otherwise specified. (Rubber cushion omitted in packing space sizes smaller than $\frac{7}{16}$".)

BELMONT 754

Square Braided Packing. Made of long fibre asbestos yarn, with a fine copper wire twisted with each strand. Braided, in same manner as square braided flax packings. Each strand of metallic yarn is thoroughly lubricated and graphited, resulting in a finished packing which lessens possibility of hardening in service.

THERE'S A BELMONT PACKING FOR EVERY SERVICE

BELMONT

PACKINGS

THE BELMONT PACKING & RUBBER COMPANY

BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

Argument Corner

(Continued from page 110)

his concern over the reference Mr Rowley made to "Scotchmen".

Mr Rowley, in his article "Plan Your Way Out of Trouble", February POWER, described some American power plants on the verge of breakdown, and he *implied* that the consultant in charge of rebuilding a plant should be as thorough and as painstaking as a Scotch consultant would be in his own country. For some reason Mr Gorrie considers this implication a mild affront to Scottish engineers.

He does not like our "hunnert" pound "bilers"—units with fire under the shell (hrt). He says we lagged in the use of high-pressure steam, we had no huge engine or mile-long line shafts, we wasted steam from "pipes stuck out from high buildings".

Mr Gorrie was upset by the sight of the non-condensing tug boat, and the rocker-beam ferry-boat engine should have been in a museum. But, the axiom "Every problem in engineering is a problem in economics" holds true today just as it did in Scotland in 1770 when Dr Small wrote to Watt and Boulton about an engine for canal boats. In fact, Small wrote, "We propose first to operate without condenser because coals are exceedingly cheap." The maximum net return for the investment was therefore the reason for using a non-condensing engine in Scotland as well as this country.

San Francisco, Calif. CHARLES HUBBARD

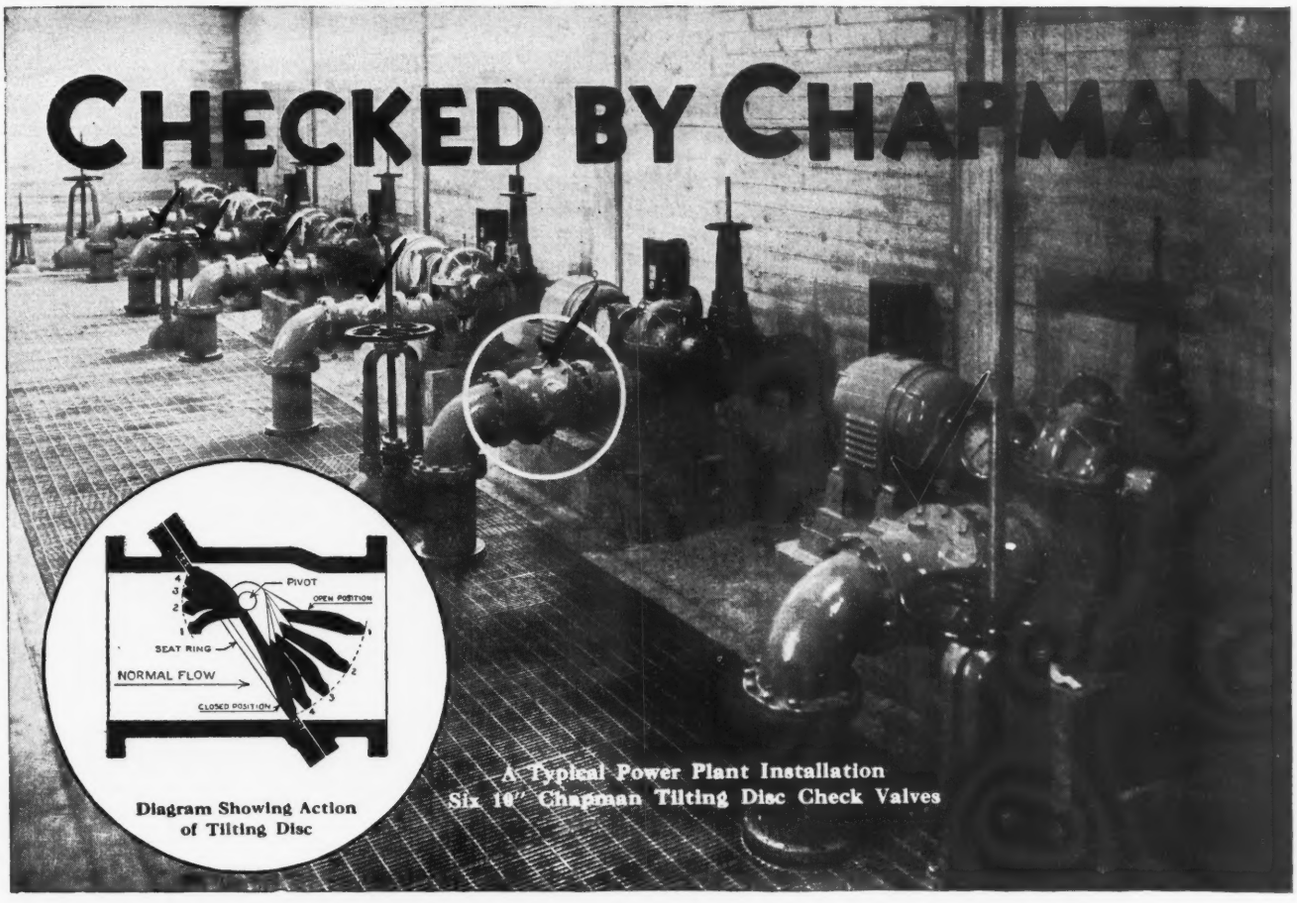
ASME Meeting

(Continued from page 120)

Specific Heats", by R C Heck, Rutgers University; "Thermodynamic Properties of Vapors", by Erich F Leib, Combustion Engineering Co; "Properties of Hydrogen Mixtures", by A W Brunot, General Electric Co; "Combined Tension-Torsion Tests on a 0.35% Carbon Steel", by E A Davis, Westinghouse Electric & Mfg Co; "Factors in the Fatigue of Helical Springs" by R R Tatnall, Wickwire Spencer Steel Co.

Hydraulic Sessions

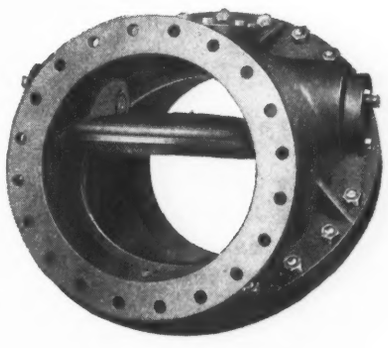
The first session of the hydraulic division was held in the Alden Hydraulic Laboratory of Worcester Polytechnic Institute, with Prof Charles M Allen as chairman and host. Seldom has this division had an opportunity to hold a meeting under more favorable and fitting circumstances. Not only were excellent accommodations provided for the meeting, but the large group in attendance was given ample time to inspect the very extensive work



CHAPMAN STEEL TILTING DISC CHECK VALVES FOR POWER PLANTS

Since its introduction a few years ago, the Chapman Tilting Disc Check Valve has successfully demonstrated its superiority over standard type swing checks in the elimination of slamming and reduction of friction losses and excessive wear.

This valve is unique in design and operation. Due to its bell-crank action, the disc clears its seat as it pivots, *lifts* from its seat when opening, and *eases* into contact when closing without rubbing or wear on seat. This cushioned closing stops slamming. The disc rides the flow lightly, without flutter, reducing wear on pivots. Head loss is reduced 65 to 80%. The valve closes drop-tight and stays tight. Its high efficiency and economy have been fully demonstrated. For the power field, with its higher pressures and exacting requirements, we recommend this valve in steel or suitable alloy, as the ideal check valve.



Interior View, Showing Streamlined Waterway

THE CHAPMAN VALVE MANUFACTURING COMPANY

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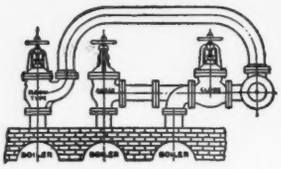
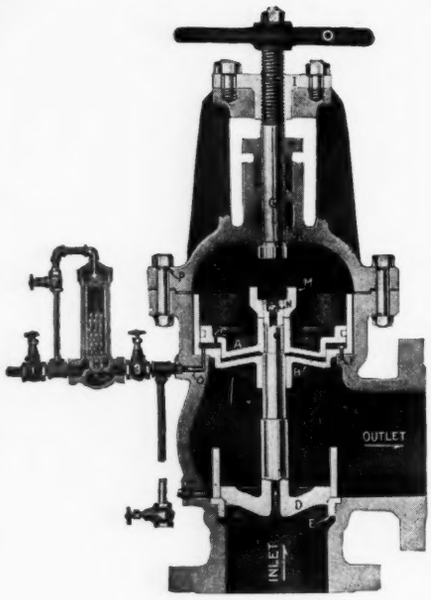
GOLDEN-ANDERSON

Specialty

VALVES





TRIPLE-ACTING NON-RETURN

• You can make safety in your boiler plant a certainty when you use G-A triple-acting non - return valves. There'll be no boiler explosions or bursting steam lines to damage life and property when you use this double cushioned valve that will not stick or chatter. Comes with either flanged ends or welded necks, and handles 150 lbs., to 1500 lbs. Test it under pressure . . . it's the heaviest valve of this kind made. In angle, globe or elbow types from 2½" to 16" in size. Free G-A catalog describing complete line will be sent to you upon request.

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being done in the laboratory, one of this country's outstanding.

Attention at the hydraulic sessions was centered around waterflow measurements and cavitation. The Allen salt-velocity method of water measurement has been used primarily for determining discharge of pumps and waterwheels during efficiency tests. In these applications, penstock velocities are usually of the order of one pipe diameter per second, and no velocity limitations of the method were indicated in this experience. Leslie J Hooper described tests made at the Alden Hydraulic Laboratory to determine the performance of the salt-velocity method at low velocities.

Three series of tests were made: the first in a 40-in. pipe, the second in a 12-in. vertical pipe in which the test section and its approaches could be readily reversed, and the third in a horizontal 2-in. pipe. The tests showed that for flow in a long straight pipe and for velocities lower than those normally found in practice, there exists a critical velocity below which good mixing of the injected brine does not occur. Finally, it was found that the effect of gravity on the accuracy of the method, when applied to a vertical pipe, is negligible as long as proper mixing is secured.

Other Tests Made

It might be inferred from these tests that it would be impossible to apply the Allen salt-velocity method to the intake of a large water wheel where the flow is very slow. During 20 years of experience with this method a large number of intake-test installations have been made. In not one of these was there any evidence of a lack of proper mixing of the brine. A factor that favors good mixing at the intake to large water wheels is the disturbing influence of the racks.

Both the Gibson pressure-time and the Allen salt-velocity methods have been used with success in several plants of the Brazilian Traction Light & Power Co, Ltd. The units in these plants range in size up to 92,300 hp, operating under 2210 ft head. Eleven units have been directly tested by each method, a total of 16 tests with the Allen method, and 15 tests with the Gibson. All of these tests have been satisfactory, and results have occasionally been such that repeated tests and checks by other methods have confirmed the accuracy of the tests. From experience gained the author, Oswald H Dodkin, suggests the following, but by no means comprehensive, precautions regarding the use of the two methods:

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for Protection of Circuits 600 to 5,000 Volts*

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Self-contained control — REDUCED STATION COST
Factory-built complete — A TESTED, FINISHED JOB
Shipped assembled — LOW AND PREDICTABLE INSTALLATION COST
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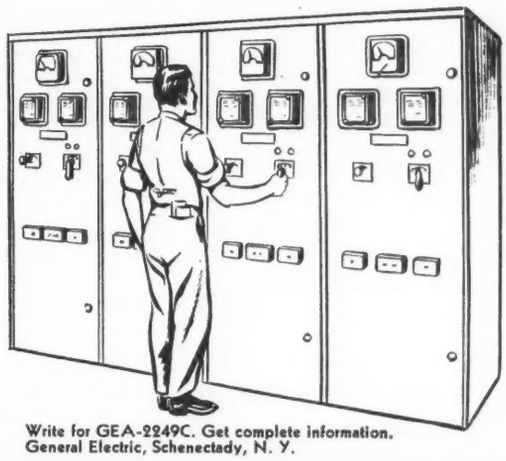

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With features found in no other instrument in its price class.

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Note these extra values this instrument brings you:

1 External knob for adjusting micrometer setting of control point.

2 Micrometer adjustment of throttling range by means of knurled knob inside case.

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4 Stainless steel, cleanable orifice in air supply system.

5 Sturdy Bourdon tube of bronze or alloy steel. Essential parts of movement of 18-8 stainless steel.

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Allen Salt-Velocity Method (1) If best results are desired, timing of the passing of the salt cloud must be done between two sets of electrodes which represent the entire cross-section of the waterway.

(2) An adequate mixing length between injection valves for the brine and the first set of electrodes is imperative for best results. The author suggests a lower limit of this length, at least equal to the mean transverse dimension of the waterway, and preferably twice this length. It appears also that the number of pop valves used should depend on this length rather than on the cross-sectional area of the waterway.

Gibson Method

Gibson Pressure-Time Method (1) The author has found that measuring the leakage with fully closed guide vanes may, at times, be the most troublesome feature of this method. In two cases it appeared that leakage through the guide vanes did not vary as the square root of the head on the turbine, thus making it necessary to measure the leakage with full head. No explanation of the discrepancies has been found, but they may be due, at least in part, to the variation in mechanical deflection of the guide vane with different pressures applied in the test.

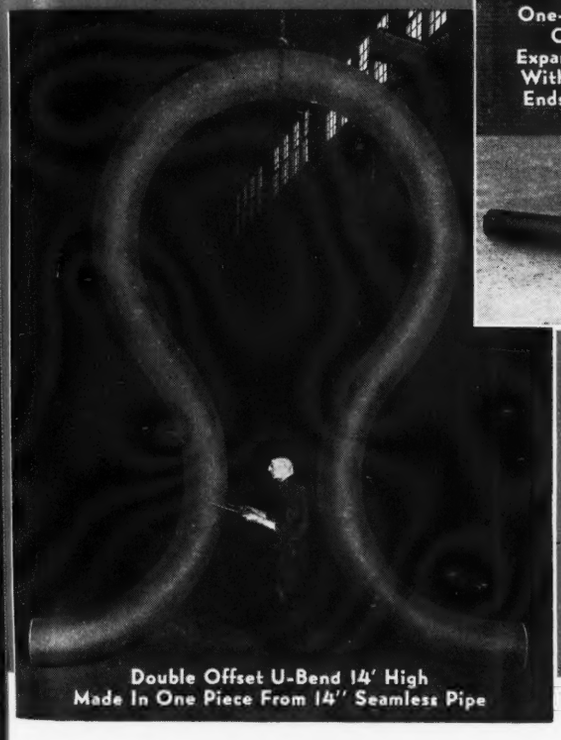
(2) Besides the necessity of absolutely tight piezometer piping, the author considers it necessary to provide adequate provision for flushing the piping between tests to remove air and to maintain penstock-water temperatures.

R E P Sharp gave an analytical discussion of waterwheel-runner cavitation based on tests made in the I P Morris and Holtwood cavitation laboratories. It is not economical to build propeller-type runners that will insure absence of cavitation over the entire area of the blade. For this reason, it is becoming general practice to preweld portions of the blades with 18-8 stainless steel having a carbon content of not over 0.8%. Mr Sharp described a stroboscopic apparatus for photographing turbine runners during operation under cavitation conditions and showed several photos taken during these periods.

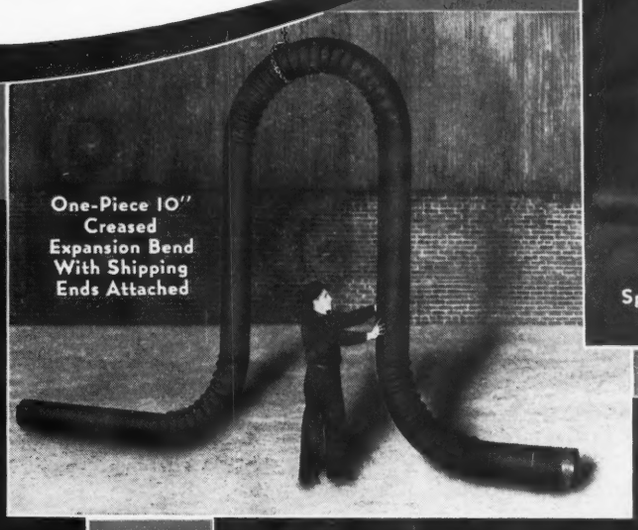
A progress report on cavitation research at the Massachusetts Institute of Technology was made by B G Rightmire, Jr. The object of this work, now getting under way, is to learn more about the mechanism of damage caused by vibratory cavitation.

EXPANSION BENDS

ACCURATELY PREFABRICATED BY PITTSBURGH PIPING



Double Offset U-Bend 14' High
Made In One Piece From 14" Seamless Pipe



One-Piece 10" Creased Expansion Bend With Shipping Ends Attached

Space-Saving 16" Creased Expansion Bend

Special 8" Expansion Bend
For 1500 # Boiler Feed Service

The four expansion bends illustrated on this page represent widely varying designs that are typical of Pittsburgh Piping fabrication. Each bend was designed for a specific installation where a given amount of expansion movement had to be compensated for in the space available.

Pittsburgh Piping has adequate shop facilities for making even the largest size expansion bends accurately to template. For example, the bend shown in the lower left hand corner required a 40 ft. length of 14" pipe for its fabrication. The bends in the center and upper right illustrations are of the Pittsburgh Piping creased type. This type of fabrication, which has been perfected to a remarkable degree by Pittsburgh Piping, makes it possible to design efficient expansion bends for confined spaces.

Pittsburgh Piping engineers are available for consultation on the proper design and fabrication of the correct type of expansion bend for any given set of conditions.

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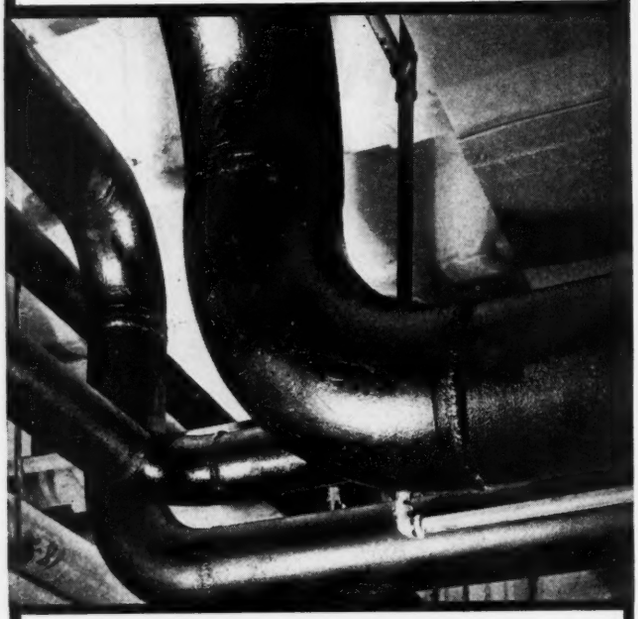
Insist on these EIGHT FEATURES



-the welder knows their value

THE eight features of WeldELLS, illustrated here, do their own talking to the man who does the welding. There is no hunting for fittings, or "sizing up", because the name, size and weight are rolled into every Taylor Forge Fitting. Lining up is made easy by the quarter-markings at the ends. Welding is a quick, gratifying job thanks to the ample tangents, the clean, machine-tool bevels and the uniform accuracy of these engineered fittings.

The finished job is better too—because it is made with fittings in which all walls are at least full pipe thickness with selective reinforcement in regions where greatest strain occurs.

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1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 SELECTIVE, UNIFORM REINFORCEMENT
4 TANGENTS
5 MACHINE TOOL BEVELLED
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE

New Plant Equipment

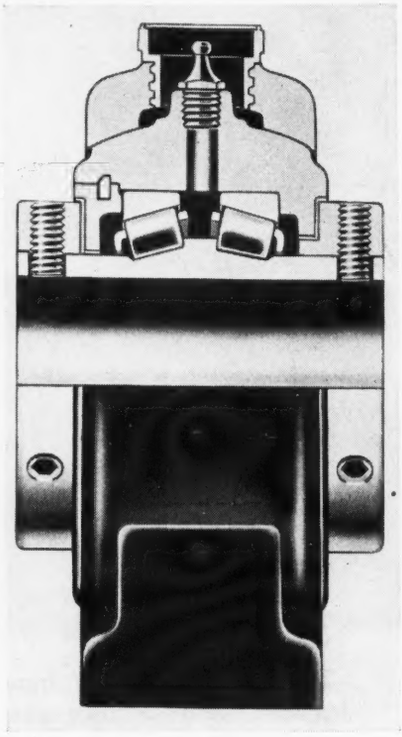
(*Continued from page* 130)

stainless-steel shaft, bronze impellers, and cutless-rubber bearings above and below each impeller. Capacities of systems range from 15 to 80 gpm from deepwells 4-in. or larger inside diameter. Pressure switch is furnished with unit or system set 20 to 40 lb. Black tanks are supplied with systems as standard equipment of either 220- or 315-gal capacity, allowing liberal amount of water to be drawn from tank between cut-in and cut-out switch points.

Deming Co, Salem, Ohio

Roller Bearing Pillow Block

DOUBLE INTERLOCK unit was designed for simplified mounting on ordinary commercial shafting where comparatively light loads are to be carried. Mounting on shaft is extremely simple. To secure bearing to shaft on which it is mounted, collars with two setscrews are placed on outside of



each end of extended inner race ring. These screws pass through unthreaded holes in race-ring, bear directly on shaft on one side and clamp race ring directly against the shaft on the other. Pillow block is made in both expansion and non-expansion types, and labyrinth seals are provided to retain lubricant and protect bearing against foreign material.

Dodge Mfg Corp, Mishawaka, Ind.

Exhauster

STRAIGHT-LINE exhauster is for handling air containing steam, dirt, fumes, paint, spray, grease, vapors, etc. Unit is equipped

Garlock Announces

LATTICE-BRAID

An Entirely New Braided Packing Construction

GARLOCK Patented LATTICE-BRAID Packings are braided *through and through*—in an entirely new and different way from ordinary braided packings.

All braided strands are lattice-linked into a structural unit, resulting in greater strength, longer life, semi-automatic action and unusual flexibility.

Special new machines enable us to make LATTICE-BRAID in a distinctive pattern which is *infinitely better* and *positively proven.*

GARLOCK LATTICE-BRAID Packing is available in the following styles: GARLOCK 730 for centrifugal and rotary pumps handling hot or cold water, caustic solutions or weak acids. GARLOCK 731 for rods operating against steam, gas, acids, lye and caustic soda solutions. GARLOCK 732 for heavy duty service against high pressure steam or hot oil. GARLOCK 736 for centrifugal or rotary pumps handling acids or strong chemical solutions. GARLOCK 751 for centrifugal or rotary pumps handling cold oil or water.

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POW. 6-40

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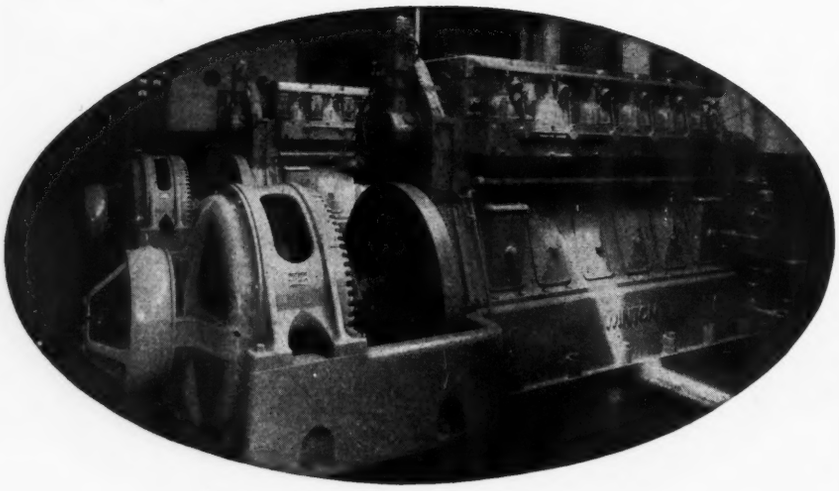
SERVICE PROVED Lubricants Assure Dependable Performance



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Experience has shown that no one oil will prove most effective and economical for a given make of engine under all conditions of operation. Such factors as power output, crankcase oil temperatures, etc., may as often as not make the use of a cheap oil expensive and an expensive oil cheap. Let one of our lubrication engineers tell you why — and prove it on your own equipment. Mail the coupon to us or write us on your own letterhead.

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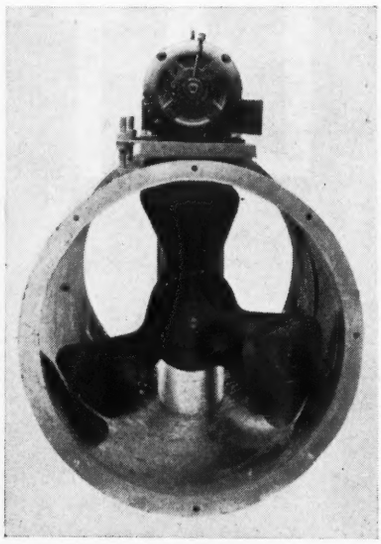
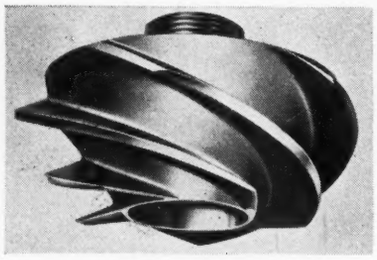
with propeller fan which delivers large air volumes against duct or wind resistance. Location of motor outside air duct keeps it cool and clean, also reducing fire hazards when air mixtures being exhausted are inflammable or explosive.

L J Wing Mfg Co, 154 W 14th St, New York, N. Y.



Pump Impellers

IMPELLERS are constructed with aluminum bronze under new process. Alloy is drawn by vacuum into steel die from a point below surface of molten metal. This molten metal rises into die in a smooth continuous flow without effect of nozzling, spraying, or pouring; steady flow of metal is



maintained until mold is filled. Impeller has a strength of 80,000 lb psi, and a Brinell hardness of 130. Aluminum bronze is composed of 89% copper, 10% aluminum, and 1% iron. Impellers can be ordered in 6-, 8-, 10-, and 12-in. sizes ranging in capacity from 50 to 1500 gpm.

Worthington Pump & Machinery Corp, Harrison, N. J.

Base-Exchange Resins

COMPANY announces the acquiring of rights to U. S. Patents of Department of Science & Industrial Research of London, England, on use of synthetic resins as acid and base-exchange compounds. New field for use of resins was discovered several years ago by the Department on Water-Softening Processes. Discovery was made, not only that certain types of synthetic resins function as powerful base-exchange media in a manner similar to the natural

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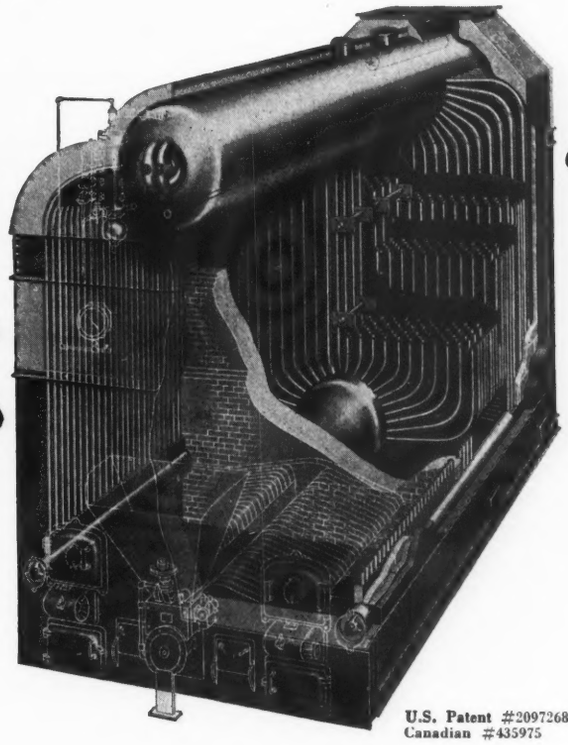
Such is the experience of one user* of a KEELER CP Steam Generator. The unit that made this saving consists of a 300 H.P. Keeler CP steam generator fired by an underfeed stoker that was formerly used under a water tube boiler of conventional design. The new boiler has more than paid for itself in a period of two years.

*Name supplied on request.

400 UNITS SOLD IN UNITED STATES AND CANADA IN LESS THAN FIVE YEARS



U.S. Patent #2097268
Canadian #435975

THE ONE AND ONLY CP STEAM GENERATOR ORIGINATED BY E. KEELER CO.

PATENTED IN U.S. AND CANADA

Sizes 50 H.P. to 1000 H.P.
Pressures to 450#.

Manufactured in Canada by Canadian Vickers Ltd., Montreal

E. KEELER CO.
WILLIAMSPORT, PA.

OFFICES IN ALL PRINCIPAL CITIES

ESTABLISHED 1864

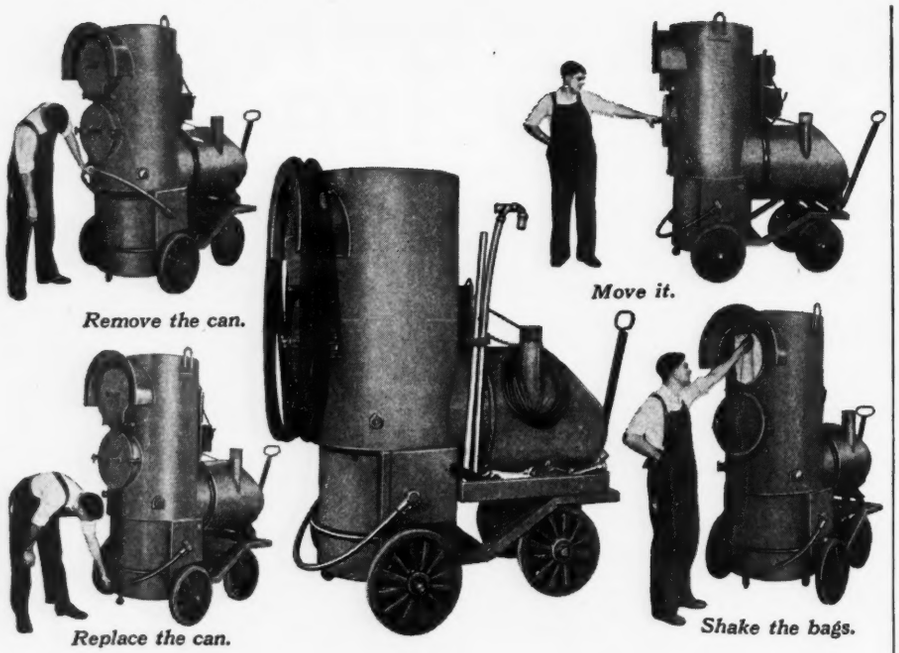
Please send copy of Bulletin F-9

Name.....

Title.....

Firm.....

Address.....



THIS SUPER-VACUUM CLEANER

is manipulated with one hand!

It's a giant for power—two men can sweep at a time with 7½ horse power in vacuum back of every move of the tools.

It's a giant for dirt capacity—7½ cubic feet—enough for a day in most plants, and the dirt can is easily moved, rolled on its own casters, emptied and replaced.

Read these specifications for a large capacity and serviceability in Spencer Vacuum Cleaning never available on wheels before.

CAPACITY: 7½ HP. Dirt Capacity 7½ cubic feet (750 lbs.). Vacuum 2" Hg. at end of 50 foot hose with a 1⅛" orifice. Blocked off: 5¾" Hg.

DIMENSIONS: Height 81½", Width 37½", Length 75½", Weight 1500 lbs.

VACUUM PRODUCER: 60 cycle, 3450 RPM. Direct connected motor (impellers on motor shaft). Only two bearings to lubricate. 25 or 40 cycle with belt drive.

SEPARATOR: Large filter area in the tubular bags. Held in place by spring steel ring, easily removed for inspection.

SPECIAL FEATURES: Hand shaker makes it unnecessary to rap each bag separately. Two inspection doors of liberal size. Four 18" wheels mounted on roller bearings. Pull handle for one man operation or tractor and ring for handling with crane. TOOLS and HOSE: Standard Spencer industrial tools and hose. Spencer swivel handle provides easy manipulation.

DEMONSTRATION: This new equipment will be demonstrated in your plant without obligation, by our nearest representative.

SPENCER HARTFORD CENTRAL AND PORTABLE VACUUM CLEANING SYSTEMS

THE SPENCER TURBINE COMPANY, HARTFORD, CONN.

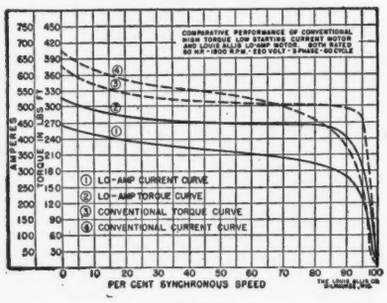
182-A

and artificial zeolites, but that in many cases the synthetic resins were more powerful and also could be adapted to a much wider range of conditions, both in anion and cation exchange. In water purification, the degree of purity required, or particular anions or cations to be removed determines type of resin used. If removal of only metal ions is required, the cation or base exchange resins can be used. Similarly, the acid exchange resins can be used alone for removal of the acid ions. In general, combinations of both are used. Although no commercial units have been installed in U. S. yet, preliminary research work is complete, and many improvements have been made as a result of the investigation.

Resinous Products & Chemical Co, 222 W Washington Sq, Philadelphia, Pa.

Electric Motor

LO-AMP motor is specially designed for use on refrigerating and air-conditioning installations. Motor has low locked rotor current and can be supplied with either low


COMPARATIVE PERFORMANCE OF CONVENTIONAL HIGH TORQUE LOW STARTING CURRENT MOTOR AND LOUIS-ALLIS LO-AMP MOTOR. BOTH RATED 50 HP.-1800 R.P.M.-220 VOLT-3 PHASE-60 CYCLE
AMPERES
TORQUE IN LBS. FT.
① LO-AMP CURRENT CURVE
② LO-AMP TORQUE CURVE
③ CONVENTIONAL TORQUE CURVE
④ CONVENTIONAL CURRENT CURVE
PER CENT SYNCHRONOUS SPEED

or high starting torque. Curves 1 and 2 on chart show inrush current and starting torque on Lo-Amp motor as compared with corresponding data on standard double-deck squirrel-cage motor.

Louis Allis Co, Milwaukee, Wis.

Pulley Covering

NON-SLIP pulley covering comes in sheets 3x3 ft, and for application is torn into strips. Enough is used to go around pul-

NEW!

large-size, low-priced welded Copper and Everdur tubes and fittings!

Seam welded tubes now available in 8" size and larger and fittings up to 24"

With this new addition, we offer the most complete line of non-rust pipe, tube and fittings available:

SEAMLESS PIPE (S.P.S.)
Anaconda 67 Yellow Brass
Anaconda 85 Red Brass
Anaconda Copper
⅛" to 12" inclusive

SEAMLESS COPPER TUBE
All standard types—⅛" to 12" inclusive

SEAM WELDED COPPER AND EVERDUR TUBE
8" and larger, in 8′ and 10′ lengths, or welded on order to 20′ and 24′ lengths

CAST BRONZE SOLDER TYPE FITTINGS
¼" to 12" inclusive

WROUGHT COPPER FITTINGS
¼" to 4" inclusive

CAST BRONZE FLARED FITTINGS
⅛" to 2" inclusive

WELDED FITTINGS*
8" to 24" inclusive—Fabricated from Copper and Everdur Sheet

ANACONDA
from mine to consumer

*Be sure to write for list prices on these new large-size welded fittings. Just ask for Publication E-9 ...no charge, of course.

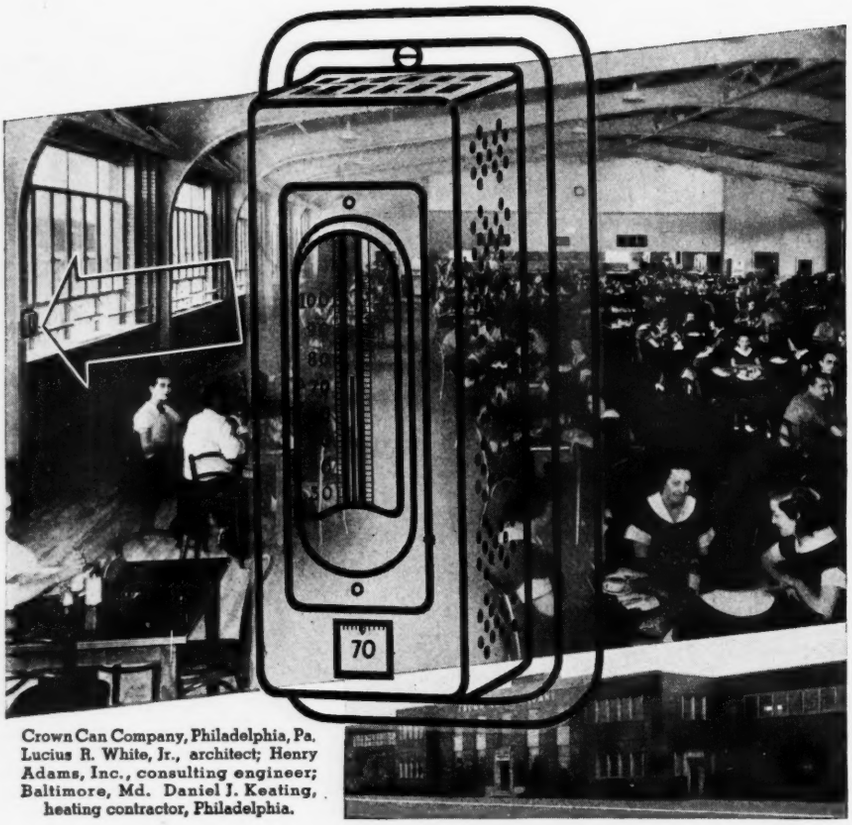
40141

Anaconda Copper & Brass

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONN.
In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Co.

• Visit the Copper & Brass Industry Exhibit in the Hall of Industry, New York World's Fair—1940.

INDUSTRIAL EFFICIENCY
with TEMPERATURES
controlled by JOHNSON



Crown Can Company, Philadelphia, Pa. Lucius R. White, Jr., architect; Henry Adams, Inc., consulting engineer; Baltimore, Md. Daniel J. Keating, heating contractor, Philadelphia.

This Philadelphia manufacturer, like other progressive producers, considers the comfort and health of employees as an important contribution to operating efficiency. Here at Crown Can, the office and cafeteria sections of the plant are equipped with JOHNSON Automatic Temperature Control, involving more than 60 room thermostats to operate radiator valves and also dampers and valves in unit ventilating machines . . . Whatever or wherever the problem in temperature, humidity and air conditioning control, the nation-wide Johnson organization is nearby, at your service with its broad experience of more than half a century.

Also: JOHNSON CONTROL FOR INDUSTRIAL PROCESSES

Send for Bulletins

JOHNSON

Automatic TEMPERATURE AND AIR CONDITIONING ***Control***

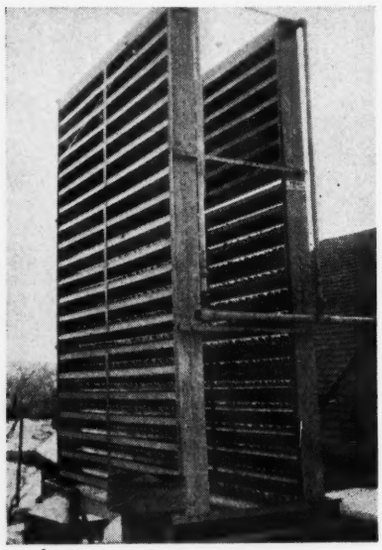
JOHNSON SERVICE COMPANY: MILWAUKEE, WIS. AND DIRECT BRANCHES IN PRINCIPAL CITIES

ley twice, including lapping, and is applied as shown in illustration. According to maker, one application lasts about 2 years. To apply, clean pulley, tear off strips of covering of proper width, soak in hot water to soften, and wrap around pulley, as illustrated.

Nonslip Pulley Covering Co, 777 Hertel Ave, Buffalo, N. Y.

Cooling Tower

TRAY towers are made in atmospheric and mechanical draft types for indoor and outdoor application. Composed of slotted-step-type trays. Water, on leaving header, is continuously broken up through slots. Long travel over trays keeps water in sus-

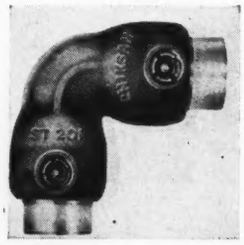


pension as long as possible until it reaches tank. This effects cooling of water to a point very near wet bulb temperature. Units are all steel, with open distributor header, no nozzles, and with slow-speed blowers.

New England Cooling Tower Co, 791 Tremont St, Boston, Mass.

Swing Joint

HIGH-TEMPERATURE joint is designed for operation at working pressures up to 500 lb, and at temperatures up to 700 F. Unit has no packing glands or stuffing boxes. All pressure or load is transmitted through double rows of hardened-steel balls in hardened races. Pressure or load required



to force joint members apart would have to equal shearing strength of the metal. Since, according to manufacturer, shearing strength is in excess of rated capacity of

NOTHING CAN REPLACE AN EXPERIENCE TABLE

WHEN CHOOSING A CONDENSER TUBE ALLOY

The combined experience of Bridgeport's Condenser Tube Engineers is an immensely valuable collection of knowledge available at all times to help solve your condenser or heat exchanger tube problems. Gathered over a period of years through actual work in the field, it is an experience table that includes nearly every conceivable operating condition, with the unique and widely different variables encountered in each one. More than likely, conditions very similar to yours are included.

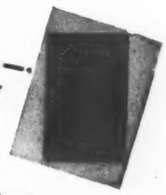
Perhaps you and your company can profit by this experience. Frequently, a Bridgeport Condenser Engineer has been able to make recommendations which, through a change of alloy, saved on the *initial cost* of tubes for a customer. In other cases an alloy slightly higher in cost than the one replaced had a life span so much greater in proportion that a *saving in maintenance* was realized. Even recommendations for slight alterations in operating conditions, at nominal cost, have resulted in substantial increases in tube life—and lowered maintenance.

If you will consult with a Bridgeport Engineer before you reorder, it is entirely possible that *you* may obtain similar savings. Why not plan on this at once?

"Bridgeport" BRASS CO.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY • BRIDGEPORT, CONN. • ESTABLISHED 1865



WRITE FOR YOUR COPY

BRIDGEPORT BRASS COMPANY,
Condenser Tube Engineering Dept. C,
Bridgeport, Conn.

☐ I'd like to have a copy of the new revised "Condenser Tube Manual."

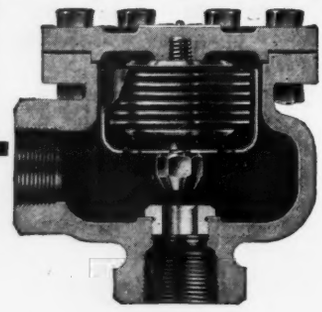
☐ I'd like to talk to one of your condenser engineers about my problem.

NAME.....

COMPANY..... TITLE.....

ADDRESS.....

CITY..... STATE.....



NICHOLSON

NON-FREEZING, HIGH CAPACITY INDUSTRIAL STEAM TRAPS

These units employ temperature difference between steam and condensate to open and close their valves, a heavy duty thermostatic bellows with brazed end plates being the operating mechanism. They are sturdily constructed and designed for high pressure and severe service. Water and air discharging capacity are extremely high and positive intermittent valve action can be absolutely depended on.

Other advantages include non-freezing, no air binding, dribbling or water-logging.

Available in types and sizes for all services from vacuum up to 300 lbs. with superheat. Ask for bulletin No. 439.

WELDED FLOATS FOR HIGH PRESSURE STEAM AND HYDRAULIC SERVICE

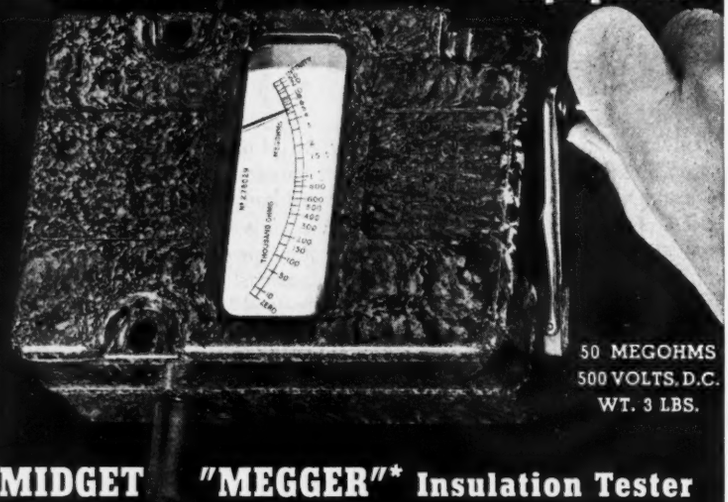
Available in spherical and elliptical shapes in sizes from 2½" to 14" diameter—in stainless steel and in chromium plated steel. Made for all steam pressures up to 1500 lbs. and hydrostatic pressures up to 2500 lbs.

"Nicholson" Welded Floats are *die formed* — not spun or laminated — with welding seam serving as reinforcing ring, and give extraordinary resistance to external pressure. Available also with cadmium, nickel or copper plating. Write for Bulletin No. 339 covering details.

Also: NICHOLSON Control Valves, Piston and Weight Operated Graps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON ST. WILKES-BARRE, PENNSYLVANIA, U. S. A.

PROTECT YOURSELF AND Your Electrical Equipment



. . . MIDGET "MEGGER"* Insulation Tester

Periodic tests of insulation resistance—using "Megger" instruments—give graphic warning of impending trouble in electrical equipment. They protect not only the equipment but *you* who are responsible for it.

Start your trouble-prevention program today by ordering a Midget "Megger" Tester.

Price—$80 net, f. o. b. Philadelphia, complete with case.

For full particulars on our complete line of "Megger" Insulation Testers, write for Catalog 1550-P.

*Trade Mark Reg. U. S. Pat. Off.

JAMES G. BIDDLE CO.
1211-13 ARCH STREET PHILADELPHIA, PA.

joint, wide margin of safety is provided. Joint is made in 6 styles for full 360-deg rotation in one, two and three planes.

Chiksan Tool Co, Brea, Calif.

Chemical Feeder

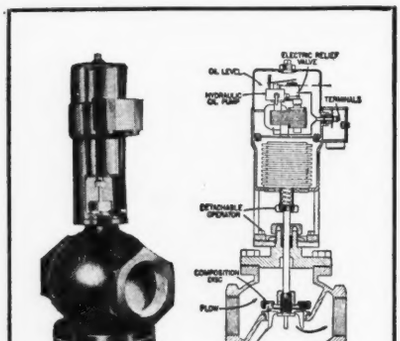
COMPOUND FEEDER is for injecting quantities of compound into boiler water as it enters boiler. Operation is entirely automatic, amount fed being easily adjusted to suit requirements. Only part

of feeder coming in contact with compound is individual pumping unit—a small, single-plunger pump. This is outside feeder body so that repairs and adjustments can be made without dismantling feeder.

Manzel Brothers Co, 326 Babcock St, Buffalo, N. Y.

Motor Valve

HYDRAMOTOR valve will handle air, gas, water, oil, brine, saturated steam, etc, and is hydraulically operated. Full-ported single-seated unit is said to afford 100% tight shut-off in any position. Electric



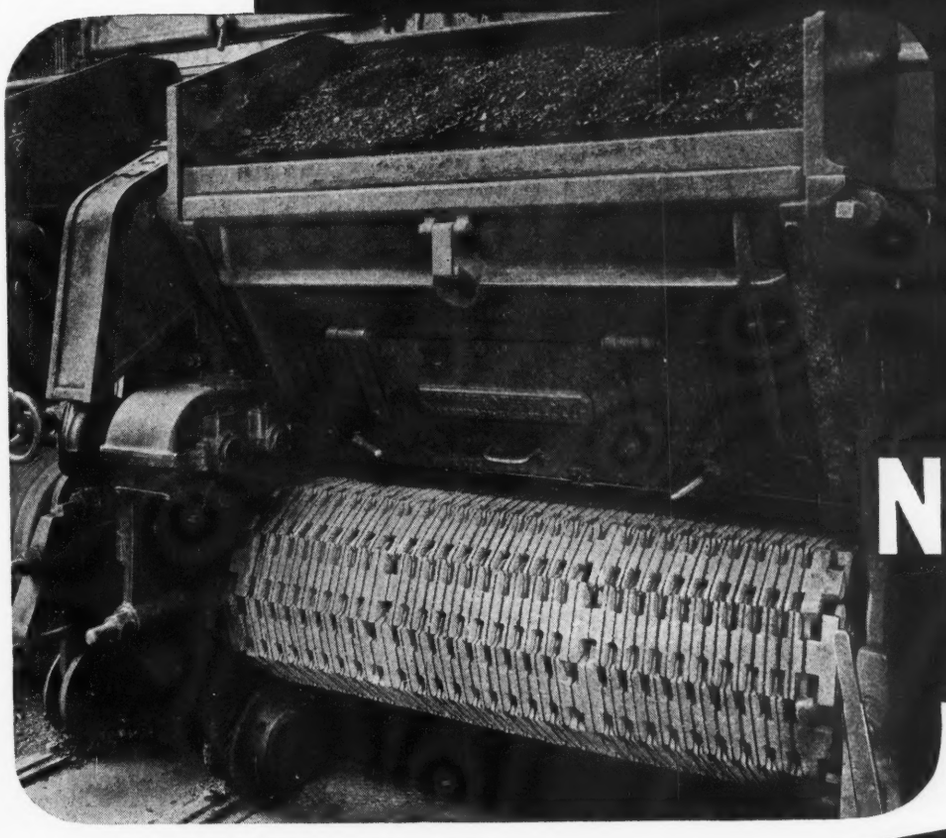
pilot valve has 2-wire current-failure control, said to have low current consumption. Operator is totally enclosed, sealed in oil and drip-proof. Valve itself is normally closed; applying current opens it. Approximate opening time is 45 sec, closing time 10 sec.

General Controls Co, Glendale, Calif.

Belt Fastener

FLEXO belt fastener made in new size for joining elevator and conveyor belts from $\frac{5}{16}$ to $\frac{1}{2}$-in. thick. Unit is constructed and

Relieves GRATE TROUBLES



1. Burning Out
2. Cracking
3. Scaling
4. Warping
5. Growth

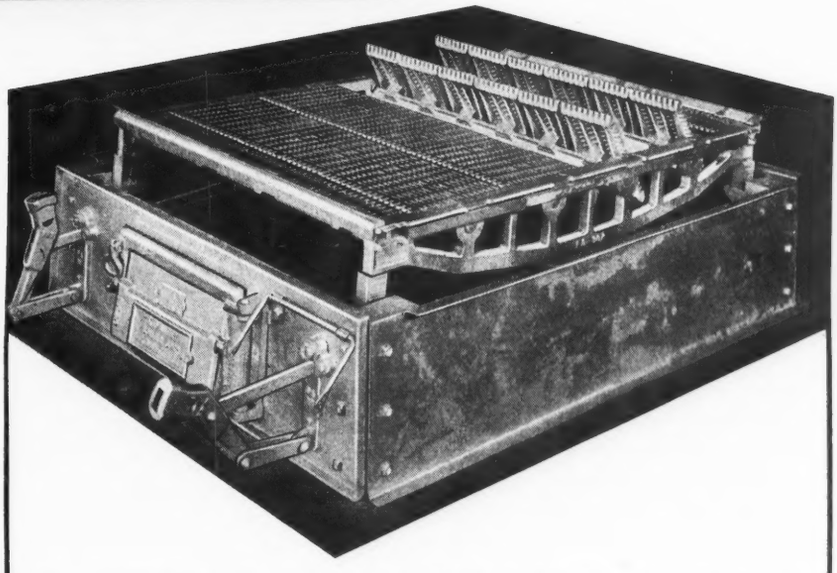
FOR LONGER LIFE SPECIFY

NICKEL

Chromium Cast Iron

For more than 10 years, the power house of the Dawes (Black Horse) Brewery in Montreal has utilized chain grates and stoker parts of Nickel-chromium cast iron. Prior to 1929, plain iron castings had to be replaced about every 9 months because of growth, burning and warping. Nickel-chromium alloyed iron castings lasted an average of 40 months.

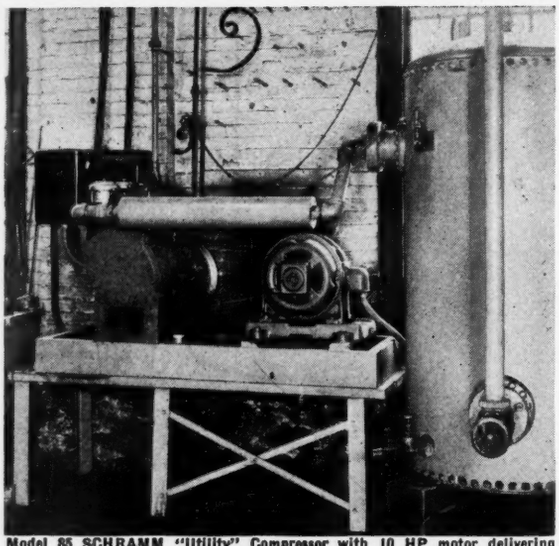
During recent years the load on this plant has increased, and a slower burning coal is used with a considerably increased draft. Under these more severe conditions plain cast iron stoker links last barely 5 months compared with 13 to 14 months for links cast in Nickel-chromium iron supplied by the Robert Mitchell Co., Ltd.



Kewanee Boiler Corp. designed this 42″ x 60″ full-dumping grate to burn small sized anthracite under natural or forced draft. To obtain resistance to heat effects and assure maximum grate bar life, Kewanee employs a 1.50% Nickel, 0.60% chromium cast iron. With this "balanced" Nickel-chromium cast iron, growth, warping, scaling and cracking are avoided. Your inquiries are invited regarding heat resistant Nickel alloyed iron castings.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

SCHRAMM
AIR COMPRESSORS



Model 85 SCHRAMM "Utility" Compressor with 10 HP motor delivering 42 cu. ft. actual air. Customer will later install 20 HP motor and get full 85 cu. ft.

When You
NEED AIR
DON'T WORRY ABOUT SPACE

SCHRAMM "UTILITY" COMPRESSORS
NEED LITTLE SPACE AND NO FOUNDATION

Sizes 25 to 600 Cu. Ft.

DIRECT "BUILT-IN" OR V BELT DRIVE

Send for Bulletin 3907

ESTABLISHED, 1900 — 758 E. VIRGINIA AVE.

SCHRAMM, INC., WEST CHESTER, PA.

A Wilson "Matched Unit"—An E P (Extra Power) Heavy Duty Air Motor and an F P T Cutter Head.

YOU GET *EXTRA POWER* WITH WILSON CLEANERS

Power in tube cleaning motors reduces "down time", labor and overhead costs and gives you a quicker, better and more economical cleaning job.

Wilson E P (Extra Power) Heavy Duty Air Motors develop from 30% to 75% *more power* but use from 25% to 40% *less air* than ordinary tube cleaning motors of the same size. They were designed for use where very hard or very heavy deposits must be removed. For speedy, safe and satisfactory tube cleaning, Wilson E P (Extra Power) motors and Wilson cutter heads and accessories are unexcelled.

Send for a copy of our new thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

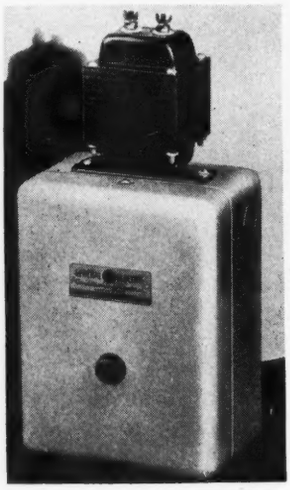
THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street — Long Island City, N. Y.

applied in same manner as others. Metal plates span joints on opposite sides of belt and are drawn tightly together by two bolts through the belting. Bolt heads and nuts are countersunk and protruding bolts broken off. Completed joint, since it is a series of separate fastenings, can assume trough of conveyor as easily as rest of belt, maker says.

Flexible Steel Lacing Co, 4607 Lexington St, Chicago, Ill.

Air-Conditioning Control Switch

MAGNETIC switch for control of air-conditioning motors operates directly from contacts of room thermostat or other low-voltage control instrument. Consists of a 3-pole magnetic switch mechanism, overload relays, and a low-voltage transformer assembled in one unit.



General Electric Co, Schenectady, N. Y.

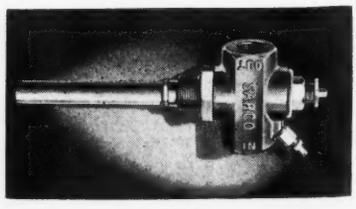
Instrument Test Kit

STICHT kit contains ammeter, voltmeter and transformer packed in container, entire unit weighing 10 lb. Instruments may be used separately without tying up others. Ammeters have a range of 5 amp, voltmeters are calibrated for 150 and 300 volts, also 150, 300 and 600 volts, and current transformers range from 1 to 250 amp primary; 5 amp secondary.

Herman H Sticht & Co, 27 Park Place, New York, N. Y.

Cooling Control

TYPE TR-40 for engine and compressor jackets, condensers and degreasers, is used for throttling flow of fresh cooling water, allowing only enough to flow to cooling



Lubriplate Lubricants make good on the

WORLD'S LARGEST CONSTRUCTION JOB

GRAND COULEE DAM

READ THE FACTS!

Paul A. Horwick, Portland, Oregon, tells how Lubriplate stands up when the going gets tough:

"Last Summer I went to Eastern Washington on a relocation project of the Grand Coulee Dam for Jacobsen and Jensen Construction Company of Portland. It was my job to maintain and grease their 1½ yard Link Belt shovels.

The first month we tried almost every brand of grease on the market. There were two reasons why we couldn't find a suitable grease. First, the heat was excessive — running 90 to 120 degrees in the open for 20 to 30 days at a time. Secondly, dust, dirt, and sand, which I have never seen equalled. If we found a grease that wouldn't run, it was too stiff for use in pressure guns. When it wouldn't melt and drop off, sand and dirt in a short time made a cutting compound, resulting in excessive wear.

"After a month or six weeks of this condition, a salesman from Nott-Atwater Company of Spokane heard of our trouble and came out to see us with a can of LUBRIPLATE No. 110. LUBRIPLATE certainly solved the heat and dirt situation besides saving 75 pounds of grease per machine per week. Where we had used four kinds of grease, we used but two LUBRIPLATE products — Nos. 110 and 130-A. Bearings cooled down and wear reduced to ⅗ of what we had become accustomed to expect."

ESTABLISHED 1870 — 70th ANNIVERSARY — FISKE'S LUBRICANTS

Try LUBRIPLATE on Your Toughest Job

WHY BUCK TODAY'S PROBLEMS WITH YESTERDAY'S IDEAS? LUBRIPLATE was developed to meet today's requirements. LUBRIPLATE has "what it takes" to stand up to the heaviest duty service—it stays put — and lasts and lasts. LUBRIPLATE is a great enemy of rust and corrosion because it resists water like a duck's back. Write us and we'll see that you receive enough LUBRIPLATE for a thorough test.

Lubriplate Division of
FISKE BROTHERS REFINING CO.
Newark, New Jersey — Toledo, Ohio

Dealers from Coast to Coast

LUBRIPLATE

THE WHITE LUBRICANT THAT MINIMIZES WEAR

BALDWIN-HILL
B-H
INSULATIONS

No. 1 INSULATING CEMENT

Effective up to 1800° F.

No. 1 in LOW HEAT LOSS
Its Rockwool base contains millions of dead-air cells which retain all their physical properties, contributing to low thermal conductivity.

No. 1 in COVERAGE
As much as 60 sq.ft., 1" thick per 100 lbs. when wet. Dry coverage is approximately 55 sq.ft.

No. 1 in LOW SHRINKAGE
Carefully selected binding agent combined with tightly rolled nodules of water repellent Rockwool cut shrinkage to the minimum.

No. 1 in ADHESIVENESS
Adheres immediately to brick or metal surface and forms a bond which strengthens upon drying.

No. 1 in ECONOMY
100% reclaimable up to 1200° F. No breakage or loss in storage. Saves time and labor in applying.

Send for Catalog giving complete data on entire line of Heat Insulation Products

BALDWIN-HILL CO.
575 KLAGG AVE. TRENTON, N. J.

* Write for Data Book

Two new Ajax forged steel Flexible Couplings with 1 1/8" and 1 5/8" maximum bores meet the trend of using alloy steel shafts carrying a high percentage of their torque capacity. Rubber bushings and graphite-bronze bearings give resilient flexibility, positive drive, free end float, and eliminate backlash, noise and lubrication problems.

AJAX FLEXIBLE COUPLING CO.
Incorporated 1920
132 English St.
WESTFIELD, N. Y.

system to maintain desired water-outlet temperature. Unit is fixed-stem type, requiring discharge from jacket or coil to be close to inlet. Bulb is installed vertically in enlarged section of water discharge line, as close to machine as possible, and with water flowing upward. Maximum working pressure is 150 lb. Regulators are calibrated at factory at any desired temperature and can be adjusted by user 25 deg above or below factory calibration.

Sarco Co, Inc, 183 Madison Ave, New York, N. Y.

Sledge-Type Socket Wrenches

LINE of wrenches available for handling large nut-turning jobs in power plants, etc, where big nuts must be down tight. Anvil end of wrench takes sledge-hammer

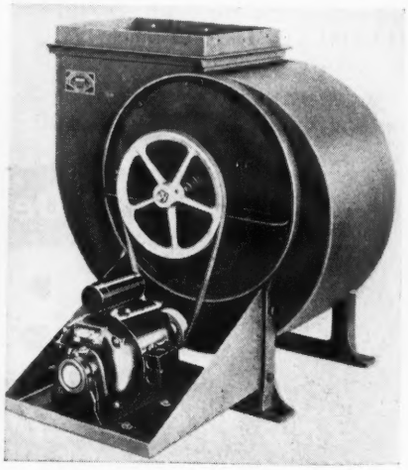
blows as bolts are tightened. Companion sockets are used where obstructions must be cleared or to reach buried bolt-heads or nuts. Available in sizes from $1\frac{7}{16}$ in. to $4\frac{5}{8}$ in.

Snap-On Tools Corp, Kenosha, Wis.

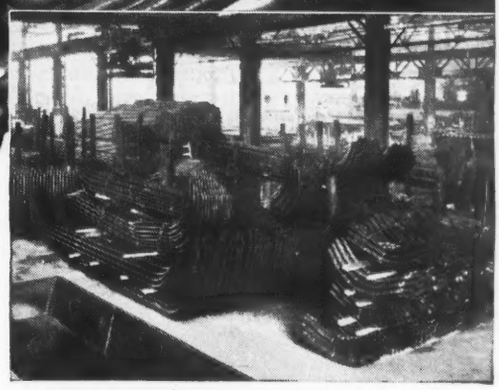
Unit Blower

AUTOVENT blower, instead of being direct-connected, is belt-driven, and maker claims many advantages. Some of these include: versatility in regard to motor size, greater portability, and wider adjustability. Unit consists of uniblade Type H blower operated by a standard-frame motor equipped with suitable V-belt drive. Motor is mounted on steel pedestal base built integral with blower housing.

Autovent Fan & Blower Co, 1805 Kostner Ave, Chicago, Ill.



TUBES IN PACKAGES!



. . . GLOBE

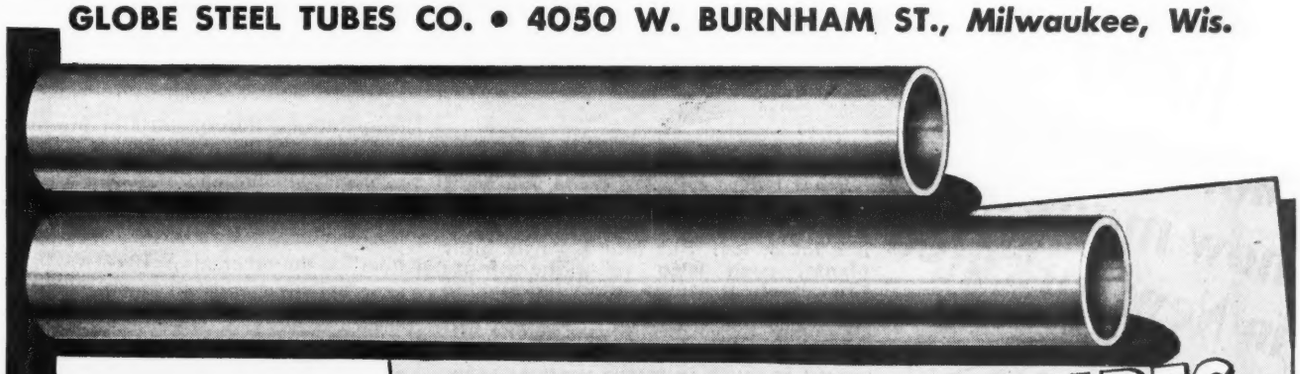
GROUP-BUNDLING SAVES TIME — HANDLING — AND INSTALLATION COSTS

SUBSTANTIAL savings in tube-handling time and installation costs are provided by the Globe method of group-bundling of tubes previous to shipment.

All Globe tubes of the same contour are sorted, grouped, and bundled at the Globe plant before loading and shipping. This pre-sorting avoids mixing of different contour tubes — re-bending — and provides greater speed and convenience in handling at the place of installation.

This organization specializes exclusively in the manufacture of seamless steel tubes. Such concentration on one product assures the purchaser of a fast, dependable source of supply and a consistently uniform quality of tubes.

GLOBE STEEL TUBES CO. • 4050 W. BURNHAM ST., *Milwaukee, Wis.*



STAINLESS TUBES
BOILER TUBES
CONDENSER AND HEAT EXCHANGER TUBES
MECHANICAL TUBING

GLOBE STEEL TUBES
Seamless for Safety

New!

PENFLEX WELD
. . . for All Services Where Leaks Are Fatal

For more than 30 years PENFLEX Asbestos Packed Interlocked constructions, and variations thereof, have been handling steam, liquids, air and gases under all conditions of pressure and temperature. Now, to take care of the new volatiles and liquids and gases of extremely penetrative and solvent natures, we offer jointless, corrugated PENFLEXWELD. With not even the slightest possibility of any seepage, this new hose or tubing is recommended for all services not corrosive to its two standard materials, bronze and steel. Sizes from 5/32" in jointless lengths as needed.

Send for Bul. 90

• • • • Pennsylvania Flexible Metallic Tubing Co.

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1000 More Tons of Ice now made Daily in New York area with FRICK

What better evidence could you want that the ice industry is going places Seven thousand 300-pound blocks a day is a lot of ice! But four recently built plants, each with up-to-the-minute Frick refrigerating and ice-making equipment, are producing it with ease. One plant harvests 37 blocks at one lift.

Refrigerating systems have been improved as much in recent years as automobiles! Is your business getting the benefit of these better methods of cooling? Let the nearest Frick Branch or Distributor assist you in making the savings now possible (up to 34 per cent!) over former methods. Write

FRICK COMPANY, Waynesboro, Penna.

Ice-making Equipment

Air Preheaters

(Continued from page 84)

through the same openings used for gas flow. However, if accumulations are moist, and are not dried out sufficiently by the passage of the relatively dry air, soot blowers are needed. Tubular preheaters are sometimes preferred because of their almost complete freedom from plugging troubles, particularly where conditions are known beforehand to be unfavorable. Corrosion effects, however, are most serious in tubular and plate types because air leakage lowers fan capacity seriously.

In most installations, cleaning preheaters is not a serious problem. Many require nothing more than washing or blowing with compressed air when the boiler is out of service for other reasons. Plugging is a serious problem with fuel oil and with midwestern coals.

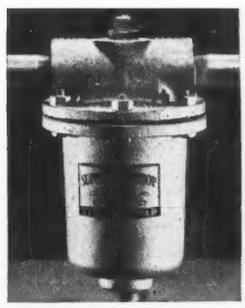
Corrosion stems from the same causes as plugging, namely moisture. It is particularly important to avoid moisture formation with high-sulphur fuels. The attack, of course, is invariably at the cold end of the preheater.

Correcting Moisture Formation

Since moisture formation is practically always due to reducing part of the gas, even a thin film, below the effective dewpoint (taking into account the agglomerating effect of soot particles) one sure correction is to return a small amount of the preheated air to the forced-draft fan inlet or by a separate fan to the low-temperature point whenever condensation is expected. Such operation, which involves some waste of fan power, need only continue when moisture-forming conditions exist, for example, with very cold winter inlet-air temperatures, during starts or low-load operation.

Since plugging and corrosion usually arise from the same causes, remedy for the one may return savings in repair bills for the other also. If corrosion is expected even with all practical operating precautions, regenerative preheaters can be built with two sets of plates, one above the other, so that only the cold end need be replaced when it becomes corroded. Replacement cost can thus be kept at a very low figure compared to total cost of preheater. Any replacement of surface in plate and tubular preheaters involves high cost because of the large amount of material and labor of replacing the entire heat-transfer surface.

Eliminate "DETOUR" Piping



. . . WITH ANDERSON SUPER-SILVERTOP TRAPS

● Detour piping of inverted bucket traps is wasteful, time-consuming and unnecessary. Straight-through piping with Anderson Super-Silvertops is quick—saves fittings and labor—is neater in appearance. This ***engineered*** steam trap simplifies the piping (either elbow or straight-in-line) without using trouble-breeding split gaskets or cored passages.

Super-Silvertop has a guided, bucket-on-a-track that insures constant, perfect parts alignment and at the same time gives equal capacity in a smaller trap. (This reduces trap costs.) Tough Anderloy valve and seat insure against valve leakage for many years. Pipe connections in the head make inspection easy and fast, with trap still on the line.

Get the complete story on all these points, write for details and prices.

THE V. D. ANDERSON COMPANY
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Super-Silvertop STEAM TRAPS

ADVERTISING PAGES REMOVED

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DUST, FLY ASH, FUME, MIST & FOG *from* GASES

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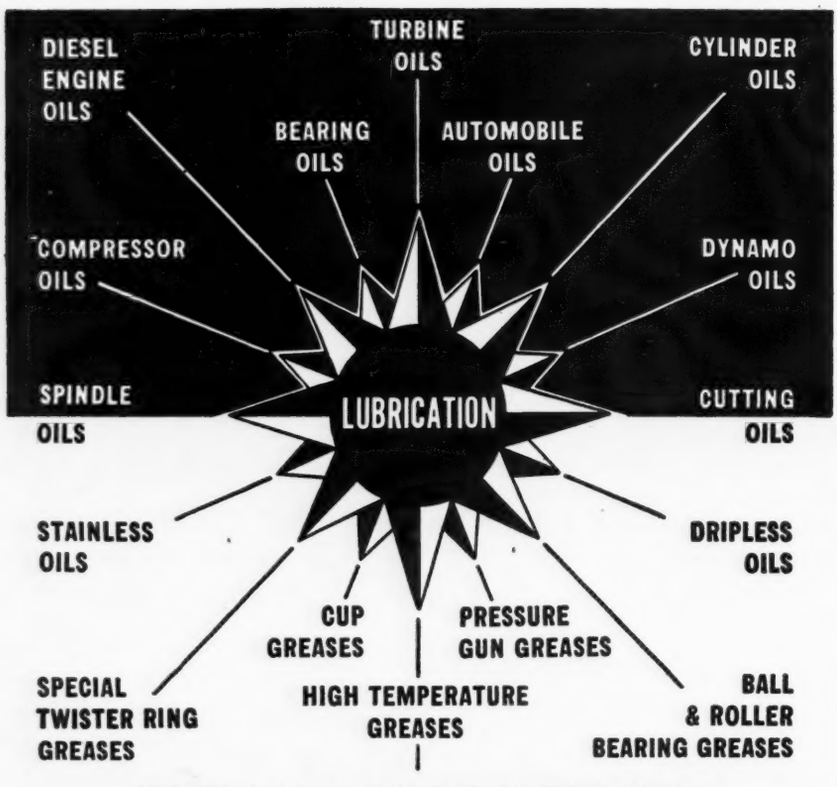

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BORNE SCRYMSER COMPANY

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Engineers' Books

(*Continued from page* 126)

Much of the text deals with principles and facts regarding the generation and use of electricity, which are basic and which have, therefore, been retained in the new edition, with such changes as developments in industry have made desirable. New methods of making electrical applications have been added and the material on the composition of matter and the electron theory has been brought into line with modern views. The section on electron tubes has been revised and extended to keep pace with the rapidly expanding use being made of these devices.

Air Conditioning

HEATING, VENTILATING, AIR-CONDITIONING GUIDE (1940). *Published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave, New York, N. Y. 1184 pages, 6x9-in., illustrated. Price $5.00 (special thumb-index edition, $5.50).*

Condensation and consolidation of text matter and use of lighter paper makes the 18th edition of this authoritative reference manual less bulky and lighter in weight. New data in old chapters and a new chapter put more information into a volume that is markedly easier to handle.

By entirely re-arranging the Catalog Data Section, products of manufacturers have been grouped into five divisions and the contents of each division outlined on a title page, with page references to each group of products and cross-references to relevant material in the technical sections. An Index to Modern Equipment provides a classified reference to manufacturers' data on apparatus and materials.

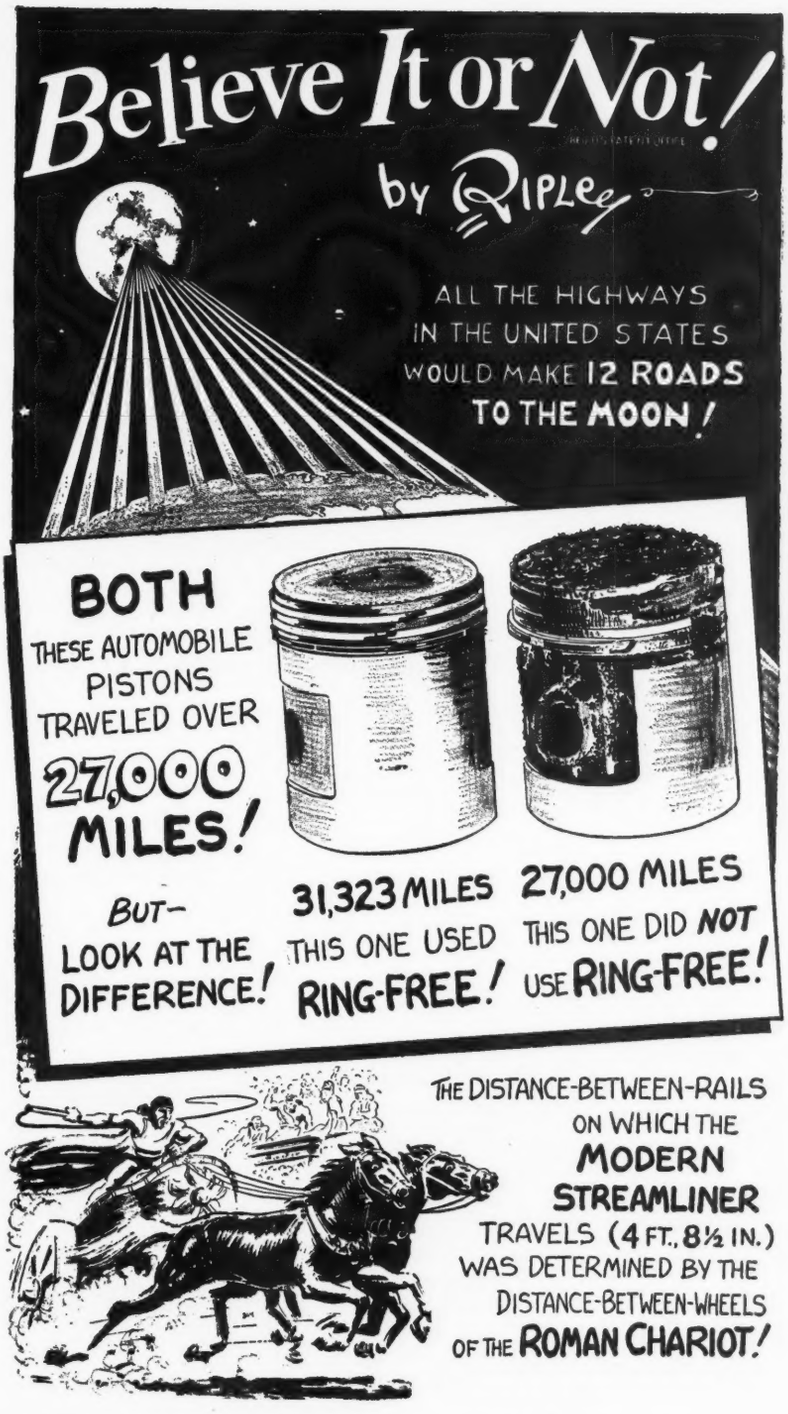
Arc Welding

PROCEDURE HANDBOOK OF ARC WELDING DESIGN & PRACTICE (6th Edition). *Published by Lincoln Electric Co, Cleveland, Ohio. 1125 pages, 5¾x9 in., 1557 illustrations, semi-flexible binding. Price, $1.50 in U. S., $2 elsewhere.*

This book is a complete, encyclopedic arc welding reference guide for designers, engineers, welding supervisors, inspectors and operators. Rapid development of the welding field is reflected in the inclusion of 20% more material than the previous edition. Contains chapters on welding methods and equipment, technique of welding, procedures, speeds and costs, structure and properties of weld metal, weldability of metals, machinery design, structures, applications.

THE WELDING ENGINEERS POCKET BOOK (1939). *Published by Chemical Publishing Co, 148 Lafayette St, New York, N. Y. 240 pages, 4x6 in., illustrations and tables. Price $1.50.*

Condensed small-size handbook contains much elementary and useful information on welding written in simple terms and


Believe It or Not!
by Ripley
ALL THE HIGHWAYS IN THE UNITED STATES WOULD MAKE 12 ROADS TO THE MOON!
BOTH THESE AUTOMOBILE PISTONS TRAVELED OVER 27,000 MILES!
BUT— LOOK AT THE DIFFERENCE!
31,323 MILES THIS ONE USED RING-FREE!
27,000 MILES THIS ONE DID NOT USE RING-FREE!

THE DISTANCE-BETWEEN-RAILS ON WHICH THE **MODERN STREAMLINER** TRAVELS (4 FT., 8½ IN.) WAS DETERMINED BY THE DISTANCE-BETWEEN-WHEELS OF THE **ROMAN CHARIOT!**

Preventing carbon is doubly important in diesels. Carbon-caked piston rings cause blow-by, loss of compression and costly overhauls. Ring-Free is the answer to these carbon-complaints. For it is endowed by Nature with the ability to actually remove hard carbon. But that's only one of the seven qualities that make Ring-Free America's No. 1 Diesel Friction-Fighter. Make us prove this. Call the Macmillan Man . . . or write us direct.

*Believe it or not!** **Lower Coast Construction Corp., General Contractors, New Orleans, La.,** say: "With another popular diesel oil our tractors had a great deal of trouble due to excessive carbon deposits and undue wear . . . pistons and sleeves had to be replaced on an average of every sixty days. Since we put Ring-Free into these tractors we have had no carbon trouble, replacement of parts and repairs have been eliminated and we can keep our equipment working full time.

"We are now using Ring-Free 100% in all of our equipment, which includes: an 8½ yard 300 h.p. Fairbanks diesel, 28 motor trucks, two 3½ yard Monighan diesel draglines, one stationary diesel, one Farmall tractor, five home light plants, four pumps and a concrete mixer . . . all with the same satisfactory performance."

*Believe it or not!** **J. A. Ball of Ball Contracting Co., Fayette, Miss.,** says of his diesel tractors: "Prior to using your oil . . . the rings in our equipment were stuck. After using your oil, about the third change, the rings were loosened up . . . since then we have been getting the maximum horsepower. Before, we had changed every 30 hours and on some units added 5 gallons every 10 hours. Now, we change oil every 72 hours with no oil added. Your oil did all, and probably more, than you claimed."

DISTRIBUTORS: A few choice territories in the United States are still available to live distributors who can qualify. Write for particulars.

*Reg. U. S. Patent Office

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A MODERN OIL PURIFIER —THE HILCO OIL RECLAIMER

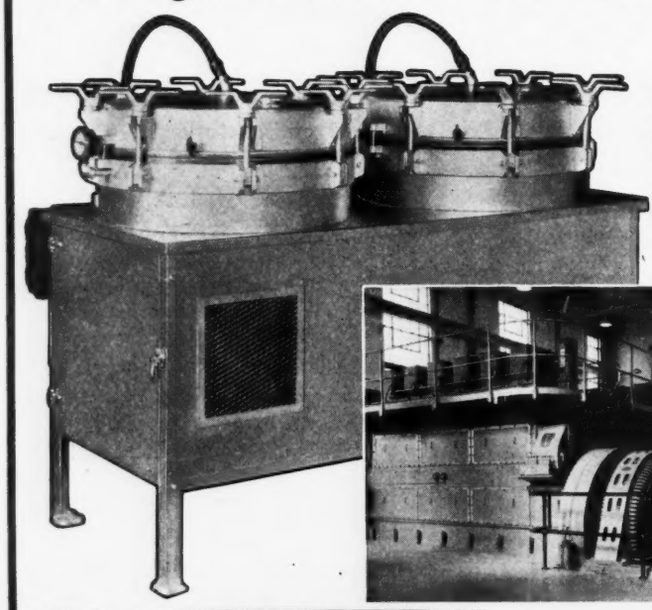
A SINGLE COMPACT UNIT

Continuous

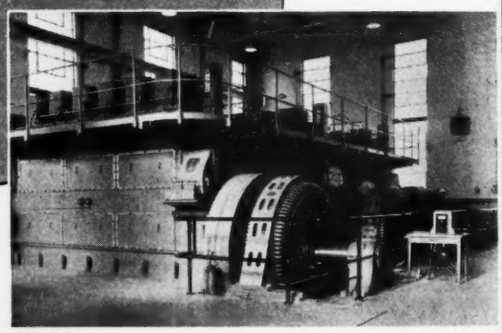
Complete

Oil Purifying

Your Engines Demand It—The HILCO Does It



Below: the Municipal Power Plant at Cushing, Okla. has a Model H Hilco Oil Reclaimer direct-connected to the lubricating system of 3—750 h.p. and 1—1250 h.p. McIntosh & Seymour Diesel Engines.



At the left the Municipal Power Plant at Sturgis, Michigan has a Hilco Oil Reclaimer direct-connected to the lubricating system of 2—875 h.p. and 1—2475 h.p. Busch-Sulzer Bros. Diesel Engines.

• • • • •

These operators, like many others, have selected Hilco Oil Reclaimers because of these super oil purifying features. Hilco Oil Reclaimers eliminate periodic oil changing and engine cleaning by keeping the oil clean and pure at all times.

The HILCO Oil Reclaimer will produce for you an oil free of carbon, sludge, moisture, fuel dilution, acid and tarry matter plus good color.

The HILCO is being direct-connected to one or more engines for continuous or intermittent by-pass purifying to remove contamination as fast as it is formed. You may use it as a batch reclaimer if you prefer draining the lube system.

A combination HILCO hookup can be arranged for both by-pass and batch operation. There is a Model having sufficient capacity for every Diesel installation.

Write for Our New Free Bulletin
"Is Your Engine Investment Protected?"

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well illustrated with sketches. Recommended for home study or quick reference. Includes chapters on electric welding of steel and cast-iron, gas cutting and welding, planning a welding shop, resistance, projection and thermit welding, protection for welders and testing welds.

Standards

ASTM STANDARDS (1939). *Published by American Society for Testing Materials, 260 S Broad St, Philadelphia, Pa. In three parts (1) Metals (2) Non-metallic Materials, Constructional (3) Non-metallic Materials, General. 3700 pages, 6x9, covering 866 specifications and tests, cloth binding. Price, any one part, $8, any two, $15, and all three, $22. Supplements to be issued in 1940 and 1941, price each year, one part, $3, two, $5, three, $7.*

For the first time, all specifications, including tentative standards, are incorporated in these volumes. The only exception is the separate volume on Chemical Analysis of Metals ($2), of interest to special groups. Part I of the three volumes covers ferrous and non-ferrous metals, general testing methods; Part II, standards for cementitious materials, concrete, masonry building units, ceramics, pipe, timber and preservatives, paints, road materials, waterproofing materials, soils, general testing methods; Part III, fuels, petroleum products, electrical insulating materials, rubber, textiles, soaps and detergents, paper, plastics, water, general testing methods, thermometers.

Electricity

INTRODUCTION TO ELECTRICAL MACHINES (1939). *By A W Hirst, Chief Lecturer on Electrical Engineering, College of Technology, Leicester, England. Distributed by Chemical Publishing Co, Inc, 148 Lafayette St, New York, N. Y. 122 pages, 6x8¼ in., illustrated, fabroid binding. Price $2.25.*

This book is the introductory volume to a series of small electrical engineering texts that can be purchased at low cost. It deals with magnetic and insulating materials, the general construction of the electromagnetic machine, losses, temperature rise and ventilation of electric machines, general method of making magnetic calculations, estimating leakage coefficient and reactance, wave form and harmonic analysis. The treatment is largely mathematical, intended for college students and practicing engineers.

Feedwater Treatment

BOILER FEEDWATER TREATMENT (2nd Edition—1940). *By F J Matthews. Published by Chemical Publishing Co, 148 Lafayette St, New York, N. Y. 319 pages, 5½x8½ in., illustrated. Price $5.00.*

Any contribution to the literature on feedwater treatment is welcome, particularly if written with a view to avoiding as many of the chemical equations and determinations as possible consistent with the requirements of testing and analysis. This

Well does this executive know that in calling upon Power Piping to do the job he brings into the picture all the facilities of Blaw-Knox . . . engineers, plants, highly-developed procedures and intimate experience in every technique of fabrication.

Scientific Control in all Processes of Piping Pre-Fabrication

Power Piping Division is fully-manned and equipped to handle all elements entering into the design and fabrication of high pressure—high temperature piping. Where specified, control for the work includes:

- Control in Bending
- Control of Grain size
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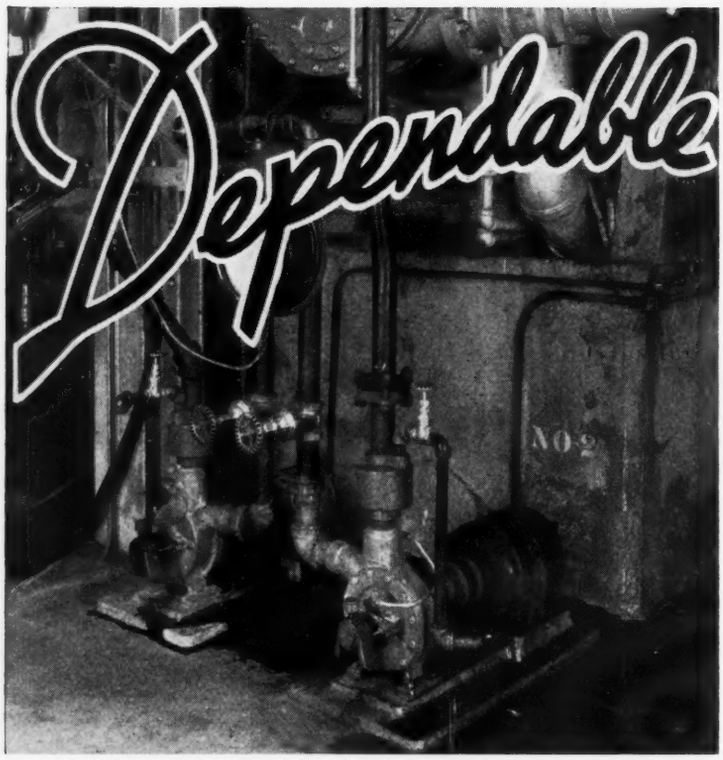
- Control of Stress relieving
- X-ray inspection of welds

Ask For NEW BOOK

FLEX-ANAL CHARTS, by E. A. Wert and S. Smith, sponsored by Blaw-Knox Company—Power Piping Division. With this book engineers can figure stresses in high pressure—high temperature piping systems by means of graphs and highly-simplified formulae. Book is priced at $3 but will be *SENT FREE* to engineers who ask for it on business letterheads.

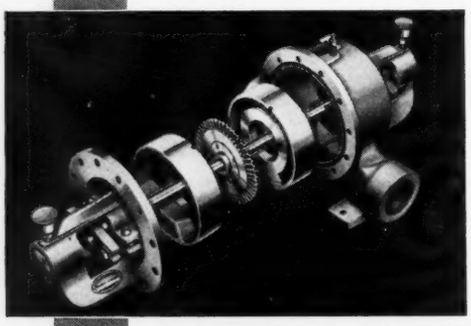
BLAW-KNOX COMPANY
POWER PIPING DIVISION

1525 Pennsylvania Ave., Pittsburgh, Pa.



Westco Pumps

Designed especially for high head—low capacity work, Westco meets today's exacting industrial demands for dependable, economical equipment. The boiler feed pumps shown above, located in the power plant of a large mid-western packer, operate against a vacuum of 27" . . . cut fuel costs . . . insure positive system efficiency. Investigate Westco in terms of your own plant hook-up. The line is complete, with pumps for liquid transfer, circulation service, boiler feed work and condensation return units.



And only Westco Pumps have patented renewable liners to protect pump casing against internal wear. This exclusive feature gives you extra years of dependable, trouble-free service . . . permits changes in pump performance merely by switching impellers and liners . . . guards against premature obsolescence. In addition, an extra set of liners and impeller provides stand-by protection at about 1/3 the usual cost. Use the handy coupon today.

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Gentlemen: We're interested! Tell us more about Westco Industrial Pumps.

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MICRO-WESTCO, INC.

book covers a wide range of subject matter and conditions experienced in Great Britain, most of which are applicable in this country.

The text can be read and understood by the average operator of a small power plant. The author's aim has apparently been to encourage an understanding of the various problems of scale and corrosion rather than to give specific prescriptions for their cure.

Pumps

SPECIFIC-SPEED CURVES FOR SINGLE-STAGE CENTRIFUGAL, MIXED-FLOW AND PROPELLER-TYPE PUMPS. *Published by the Hydraulic Institute, 90 West St, New York, N. Y. Price 5 cents.*

In 1932 certain centrifugal manufacturers plotted curves representing the upper limits of specific speed in respect to capacity, speed, head and dynamic suction lift or head to which, according to their experience, centrifugal pumps may be applied with assurance of freedom from cavitation. These curves have been slightly modified in the light of experience and it is now the opinion of the subscribing pump companies that it is to advantage of pump users to buy and operate them within the limits indicated by these curves.

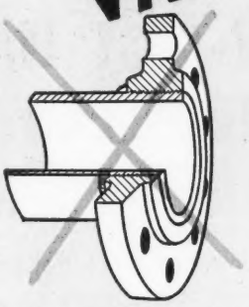
Brief Reviews

FLUID-FLOW MEASUREMENT BY HEAD-TYPE METERING ELEMENTS (1939). *By F C Stewart and J S Doolittle, Pennsylvania State College. Published by Instruments Publishing Co, 1117 Wolfendale St, Pittsburgh, Pa. 24 pages, 9 x 12 in. 34 illustrations, paper cover. Price 50 cents.* This is a mathematical paper dealing with venturi tubes, orifices, nozzles and pitot tubes. The treatment is restructed to: (1) consideration of flow problems involved in a conduit to transport liquids or gases from one location to another and (2) the measurement of flow of fluids in a conduit. Five problems are worked out to demonstrate the use of the method developed.

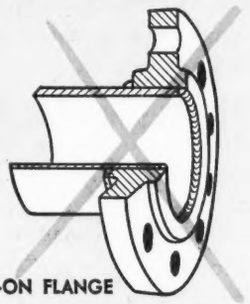
ASTM SPECIFICATIONS FOR PIPING MATERIALS FOR HIGH-TEMPERATURE AND HIGH-PRESSURE SERVICE. (1939). *Booklet, 6 x 9 in. provides selected group of specifications in convenient form. Published by American Society for Testing Materials, 260 S Broad St, Philadelphia, Pa. Price $1.25.* Covers carbon and alloy steel pipe and boiler tubes, classification and dimensions, wrought iron, castings for valves and fittings, bolting material and nuts.

GERMAN-ENGLISH GLOSSARY FOR CIVIL ENGINEERING. *By Alphonse A Brielmaier. Published by University of Illinois, Urbana, Ill. Paper bound, 37 pages, price $.45. Circular series No. 40.*—Engineers reading foreign literature often have difficulty in determining the English meaning of unfamiliar technical terms. This glossary is intended to assist him in consulting German civil-engineering publications. Present usage in German practice was reflected by words compiled from several modern German works in each of the sub-

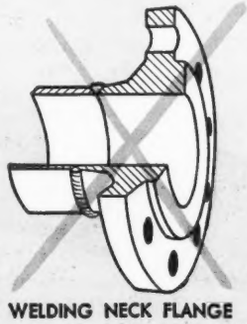
MIDWEST VAN STONE WELDING NIPPLE makes the *ideal* flanged joint for welded piping systems



SCREWED AND WELDED FLANGE



SLIP-ON FLANGE
WELDED FRONT AND BACK



WELDING NECK FLANGE

For making connections to boilers, pumps, valves and other flanged outlets (and where piping must be frequently cleaned or inspected for corrosion), Midwest Van Stone Welding Nipples have a tremendous advantage over flanges that are welded to the pipe (see drawings at left). The swivel flange of the Nipple makes it unnecessary to accurately line up the bolt holes before welding; "setting up" is simple and quick because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. The result is a real saving in time and cost of welding.

Another important economy is in erection. Field organizations report a saving of 25% in erection time for making up a joint using Midwest Van Stone Welding Nipple in comparison with flanges rigidly fixed to the pipe; this saving is even greater when the flanges are on bends.

Ask for Bulletin WF-36 which gives complete data regarding Midwest Van Stone Welding Nipples . . . and other Midwest Welding Fittings that simplify and save on welded piping.

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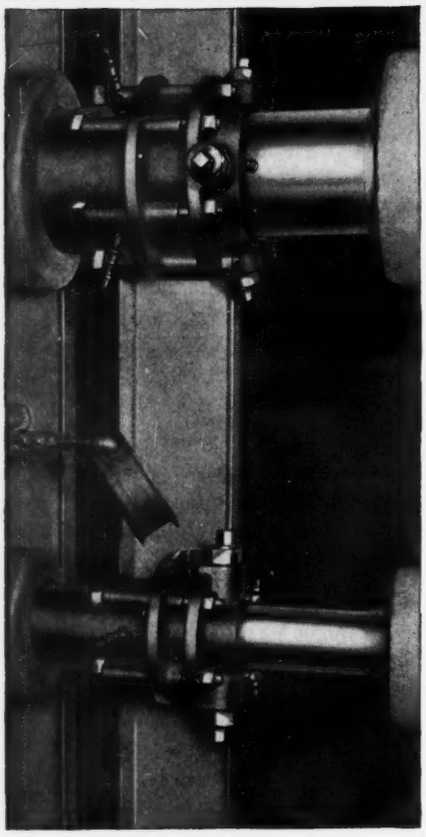
YARWAY
GUN-PAKT
EXPANSION
JOINTS



Big Automobile Company Uses 67 Yarway Joints

First purchased 3 years ago. Reordered 7 times to present total of 67 Yarway Gun-Pakt Joints, ranging in size from 3 in. to 14 in.

Why don't you select the Expansion Joint that is packed under full steam pressure. A twist of a wrench forces a special semi-plastic packing into the stuffing box by means of integral pressure guns. No need to remove old packing. New packing rejuvenates the old. No need to shut off steam. Write for Catalog EJ-1907.

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100 Mermaid Ave., Phila., Pa.

divisions of civil engineering and from current technical periodicals. The English meanings are those which would be used in American practice.

MECHANICAL WORLD YEAR BOOK (1940). *Published by Emmott & Co, Ltd, 31 King Street West, Manchester, England. 220 pages, cloth bound, many charts and tables. Price about $.30.*—Contains, in addition to post office information, price equivalents, metric and British conversion tables, a classified buyers' directory, and assorted technical information, together with tables showing trigonometric functions, comparative stresses, weight-calculating data, and diary for 1940.

INDUSTRIAL HAZARDS OF STATIC ELECTRICITY. *By Harold J Davis, Safety Engineer. 9 pages, paper bound, price $.25.*—Gives a comprehensive treatment of the dangers in static electricity, commonly thought to be one of the lesser hazards. Presents briefly origin of static electricity and some helpful remedies.

ELECTRICAL YEAR BOOK (1940). *Published by Emmott & Co, Ltd, 31 King Street, West, Manchester, England, 376 pages, cloth bound, tables, charts. Price about $.30.*—Has similar useful tables found in Mechanical World Year Book and in addition all technical data of use to electrical engineers. Has sections on synchronous motors, ac and dc motors. switches, transmissions, transformers, etc.

$200,000 INDUSTRIAL PROGRESS AWARD PROGRAM. *Published by James F Lincoln Arc Welding Foundation, Cleveland, Ohio. 48 pages, paper bound. Available gratis to those interested in work of program.*—Document gives object and purpose of 2½-year industrial study program and cites terms and conditions upon which awards are to be made.

Power Lines

Joliet Station Adds 25,000-kw Superposed Unit

By the addition of a 25,000-kw superposed turbine-generator now under construction by General Electric, the Joliet station of the Public Service Co of Northern Illinois is being changed from a plant operating at 300 lb to one running at 1250. The new unit will provide the additional 25,000 kw of generating capacity for about 5300 Btu per kw hr and effect better than a 20 per cent reduction in heat rate. This is the third addition which has been made.

Santry Elected Combustion Head

Joseph V Santry was elected president of Combustion Engrg Co, New York, at the annual organization meeting held recently. He succeeds Frederic A Schaff, who was elected vice-chairman of the board. George L Bourne was re-elected

Another OAKITE IDEA to help you save!

LOW-COST WAY TO CLEAN PLANT FLOORS

Whether your floors are of wood, slate, concrete or terrazzo, you can keep them clean and slip-proof with half the effort and at an amazingly low cost the successful Oakite way!

Yes! With modern Oakite materials and methods to make your floor cleaning routine easier, every trace of grease, oil, trampled-in dirt is speedily removed. Floors are spic-and-span, quick-drying, safe to walk on. No dangerous, slippery film. Besides, cleaning is accomplished with complete safety both to floors and workmen.

Save Money ON ALL POWER PLANT MAINTENANCE JOBS

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Prevent corrosion – the DEARBORN WAY

All water supplies are objectionable from the standpoint of corrosion — especially in boilers operated at high pressures and temperatures. Feed lines, tubes, drums, and economizers may be gradually weakened to a point where costly repairs are necessary.

You can prevent corrosion in your boiler with Dearborn Water Treatment. First of all, Dearborn engineers will make a thorough investigation of the causes of corrosion in your plant and determine the chemical and mechanical treatment necessary for its control. These recommendations will be based upon an intimate knowledge of the corrosion problem obtained through years of laboratory research and field experience.

Dearborn Treatment is also balanced to provide full protection against scale and to reduce the possibility of steam contamination. If scale is already present, the treatment can be controlled to disintegrate the scale without boiler shutdowns. The cost of this treatment and supervisory service is small compared with the savings it brings.

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How Dearborn Prevents Trouble in Your Boiler

Dearborn engineers first make a thorough analysis of boiler and plant conditions. Then, a complete chemical analysis of the feedwater is made in the Dearborn laboratories. Not until then are the proper treatment and control methods recommended. Next, feeding equipment is provided to suit the individual plant, and the engineer is instructed in water testing and treatment control. Finally, frequent calls are made by the Dearborn representative to see that correct conditions are constantly maintained in the boiler.

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The AMERICAN WATER SOFTENER CO.

WATER REFINING EQUIPMENT HEADQUARTERS

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chairman of that body. Mr Bourne is also chairman of the company's parent organization, The Superheater Co, of which Mr Schaff is president.

Martens H Isenberg, who has been vice-president in charge of production, was elected executive vice-president to succeed Mr Santry. Robert M Gates, vice-president in charge of sales since 1933, resigned to accept the presidency of Air Preheater Corp, a company affiliate. Albert C Weigel, formerly assistant to the president, was elected a vice-president, and Harold H Berry, John Van Brunt, F H Rosencrants, Charles H True, and John S Skelly were re-elected vice-presidents.

Other officers re-elected are Harold H Berry, treasurer; George D Ellis, secretary and controller. Following re-appointments were also made: I B Swigart, assistant secretary and treasurer, Thomas F Morris, assistant secretary, and Frank R Fitzpatrick, assistant to vice-chairman.

Pure Water for the Marines

American Water Softener Co, Philadelphia, Pa., has been awarded two contracts by the U.S. Government for supplying self-contained water-supply and water-purification units. First contract calls for eight portable units for the Marine service and the second calls for eight for the Army.

Each unit for the Marines consists of a gasoline-driven self-priming pump, sand filter, soda ash and alum feeders, direct feed chlorinators, and all necessary connecting piping and hose. Capacity of each unit when filtering is 50 gpm and when pumping direct from source of supply to service, (by-passing filter) is 100 gpm against total head of 75 ft. All equipment will be mounted on trailers.

Mobile units for the army are similar in construction and operation to the previously mentioned units, except that capacity is 100 gpm against a 90-ft head, and the filters have a capacity of 100 gpm. All of this equipment will be mounted on 6-wheel GMC trucks driving through three axles. The government will furnish the chassis, and company will mount the units.

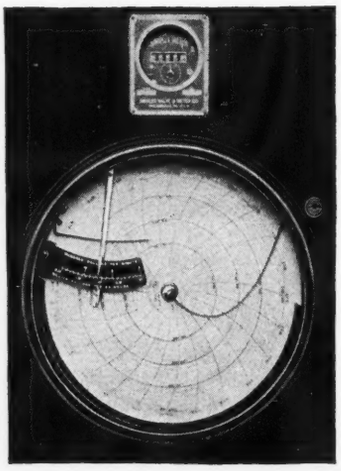
ASRE to Induct Three New Sections

Featuring the formal induction of three new sections which have been formed during the year, the 27th Spring Meeting of the American Society of Refrigerating Engineers will be held at the Skytop Club, Skytop, Pa., June 9, 10, and 11. The new sections were formed in Richmond, Pittsburgh, and Cincinnati.

The technical program will take place Monday and Tuesday mornings, consisting of two 2-hour sessions with intermissions each morning. Afternoons will be left free for golf on the Skytop courses. Some of the papers to be presented include "Refrigeration in Chemical Industry", by D H Killeffer; "Performance of Heat Exchangers", by David Crampton, Wallace & Tiernan Co; "Effect of Superheat on Capacity of Commercial Compressors", R H Tull, Westinghouse Co; and "Design Problems in the Distribution of Air", by Walter Grant, Carrier Corp.

SIMPLEX METERS

THE UTMOST IN ACCURACY



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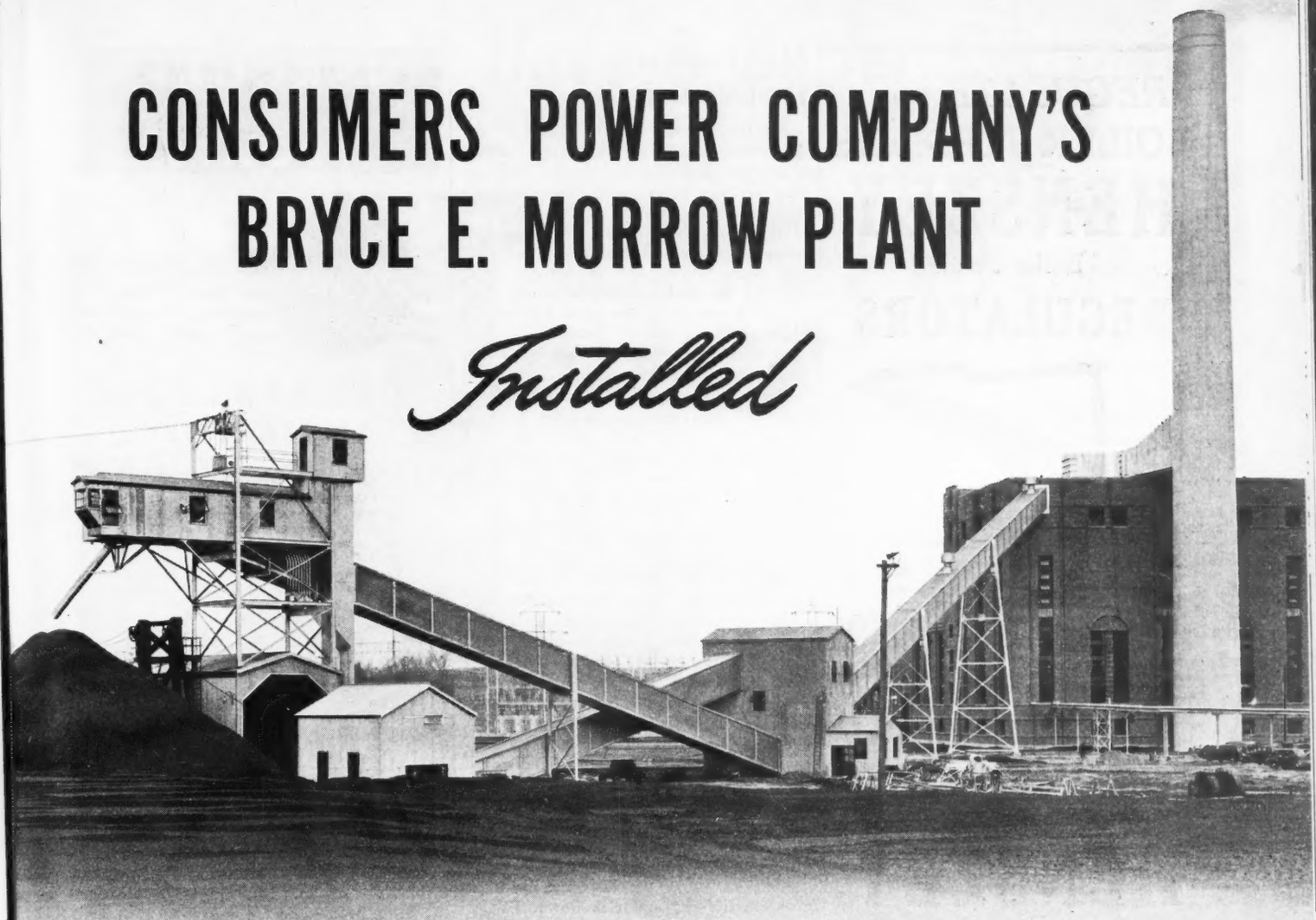

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● Complete with a 90 ton capacity track hopper that is discharged with two belt feeders, a coal crusher, three belt conveyors having 156, 189 and 320 foot centers respectively, a coal storage and reclaiming system with a 54 foot high control tower, and a dust tight flight conveyor (vented with a fan) that distributes coal to the bunkers, Bartlett-Snow equipment at the Bryce E. Morrow Plant, like other Bartlett-Snow installations, has met fully the customer's requirements.

Designed by men who do now—and have for years—devoted their entire activity to coal handling problems . . and fabricated to Bartlett-Snow's nationally recognized standards in our own machine and structural shops under the exacting inspection of the designers themselves instead of being jobbed out to other fabricators—Bartlett-Snow equipment is ideally suited to the individual requirement . . . and in addition, reflects the many refinements and niceties of design and fabrication that promote efficient and trouble-free operation in service.

That is why you'll find Bartlett-Snow coal handling equipment being selected in preference to other equipment by many of the best known and most representative central stations—and large, medium and small industrial boiler plants alike . . . It meets the need more accurately and works better. More complete information including illustrations of recent installations, equipment details, etc., are contained in a 48 page bulletin, copies of which will be sent on request. Send for your bulletin today.

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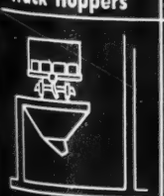	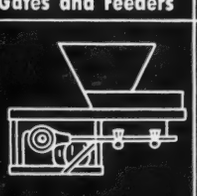	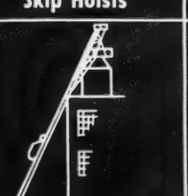	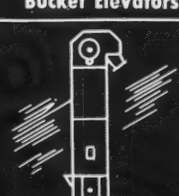		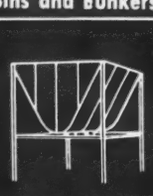	

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REGULATORS

The Henszey Boiler Feed Regulator is a self-contained unit—goes right in the line—needs no additional structural supports. It accurately controls the boiler water level at all loads.

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MEASURE your
BOILER FEED with
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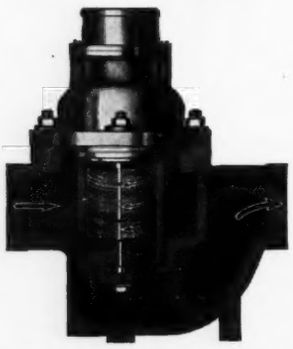

Use the Henszey Boiler Feed Meter to accurately measure the quantity of boiler feed water that is regulated by the Henszey Boiler Feed Regulator. It goes right in the feed line and will measure the pulsating discharge of a reciprocating pump.

Send for catalogs describing both these instruments in detail.

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ASME Features Three Meetings

For the first time in the history of the American Society of Mechanical Engineers, the semi-annual meeting will be held in three cities simultaneously. Meetings will take place in Milwaukee, Wis., at the Hotel Pfister, June 17-20; in Ann Arbor, Mich., at the University of Michigan, June 20-21; and in Asbury Park, N. J., at the Berkeley-Carteret Hotel, June 19-22. Featured at the main meeting in Milwaukee will be 13 technical sessions with 30 papers covering hydraulics, steam power, education and training, etc.

The meeting at Ann Arbor will present four technical sessions, devoted to elasticity, dynamics, fluid mechanics and thermodynamics. Besides an exhibit of Diesels and accessories, the meeting in Asbury Park will include six sessions with 12 papers on Diesel fuels, shaft couplings, marine diesels, engine design, operation and maintenance.

Papers to be presented at the main meeting include "Steam Turbine Blading", by R C Allen, Allis-Chalmers Mfg Co; "Progress in Design and Performance of Modern Large Steam Turbines", by G B Warren, General Electric Co; "Turbine Blade Testing", by R P Kroon, Westinghouse Elect & Mfg Co; "Centrifugal Pump Efficiency Measurements" by R W Angus, Univ of Toronto; "Parallel vs Individual Operation of Multiclones", by L C Whiten, Jr, Prat-Daniel Corp; "Development of a Major Principle in Pulverized Coal Firing", by F L Dornbrook, Wisconsin Electric Power Co, and others.

Some of those papers which will be given at the Oil and Gas Power Div in Asbury Park are "Diesel Fuels for Large Unit Power Generation from the Operator's Viewpoint", by J Bryan Sims, Grand Haven, Mich; "Fluid Couplings" by L N Alison, American Blower Co; "Stress and Deflection in Reciprocating Parts" by R L Boyer and T O Kuivinen, Cooper-Bessemer Corp; "The Combustion-Gas Turbine" by J T Rettaliata, Allis-Chalmers Mfg Co; "The Significance of Diesel Exhaust-Gas Analysis", by John C Holtz, U. S. Bureau of Mines.

Power Show Committee

Personnel of the advisory committee for the 14th National Exposition of Power and Mechanical Engineering to be held in December was recently announced. It includes:

I E Moultrop, chairman; John H Lawrence, vice-chairman; Comfort A Adams, E G Budd Mfg Co; Homer Addams, past president, American Society of Heating and Ventilating Engineers; J T Barron, Public Service Electric & Gas Co; R E Dillon, Boston Edison Co; Fred Felderman, past-national president, National Association of Power Engineers; A C Fieldner, chief, Technologic Branch, U. S. Bureau of Mines; N E Funk, Philadelphia Electric Co; F E Giesecke, president, American Society of Heating and Ventilating Engineers; G E Hulse, president, American Society of Refrigerating Engineers; George L Knight, Brooklyn Edison

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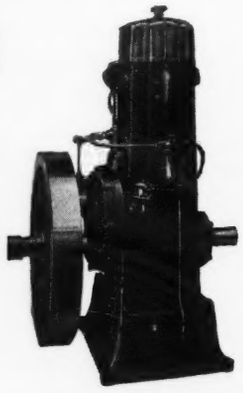

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Condor WHIPCORD V-BELTS

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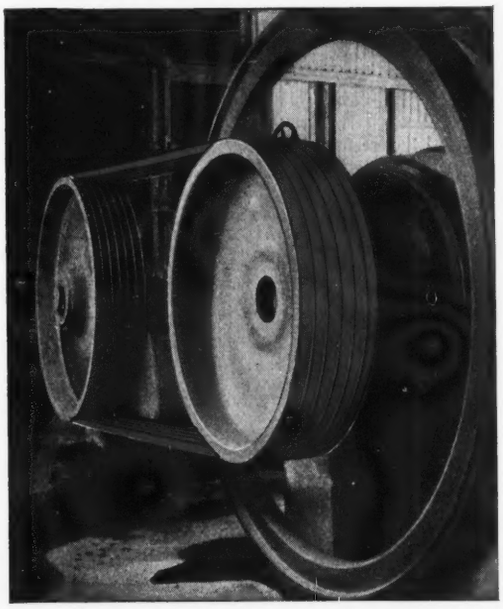

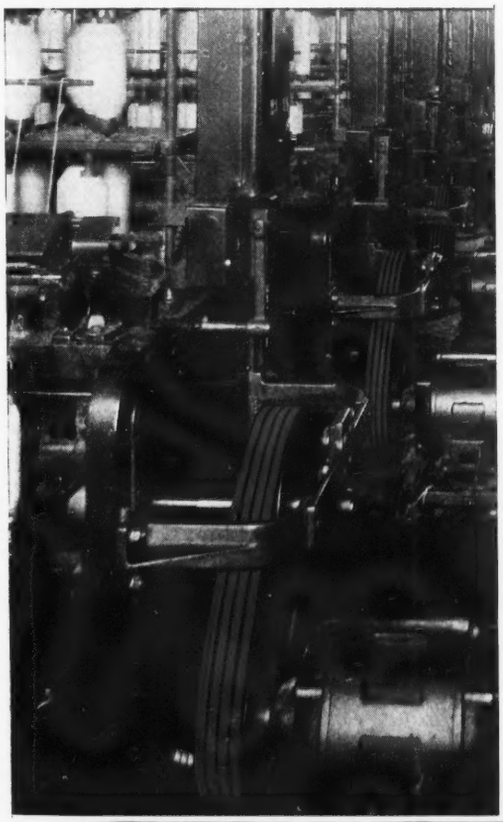

1. **Wide margin of strength**—to take care of starting, peak or shock loads—obtained through endless "Whipcord" construction.
2. **Low ultimate stretch.** We know of no other construction which approaches Condor's extreme lack of stretch. That accounts for their long life in service.
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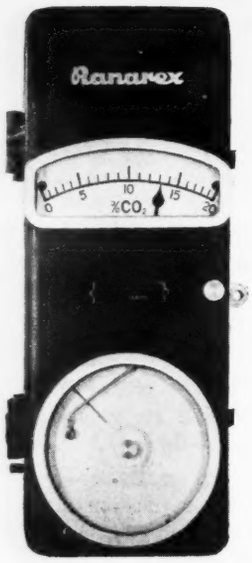

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The show will be held in Grand Central Palace, New York, from Dec. 2-7, 1940 and will include exhibits from more than 200 exhibitors. The affair is being managed by International Exposition Co.

Tube Test Results

Results of tests on rolling-in of tubes into headers by the Gulf Oil Corp, the Timken Roller Bearing Co, and the Key Co were announced recently in a report issued jointly by the three companies. The following conclusions were drawn from the investigation and experiment:

(1) Header material should be considerably harder than the tubing to assure well-developed shear points. The report suggests that headers for the installation of alloy tubes with a maximum hardness of 163 Brinell should be heat-treated to a hardness of 229 Brinell minimum.

(2) Insufficient rolling or too much rolling will cause joints of doubtful quality. Too much expansion of the tube into the tube hole will result in an excessive flow of the tube material out of the header with the danger of shearing off proper shear points which already had been formed.

(3) Use of wide angle flaring rolls on the expander tool is discouraged as the flaring of the tube ends causes a longitudinal flow of the tube material endangering satisfactory shear points which have been formed by the expander rolls.

Conclusions reached in this survey give support to the belief that it is sound engineering practice to upset and machine to close tolerances tubes which are rolled into headers, keeping in mind the precautions that have been outlined above.

New Metal Stronger Than Steel

Stronger at 1100 F than any known steel, creep rate less than one one-hundredth that of nickel-chrome steel, new Westinghouse alloy K-42-B retains strength at 2000 F. Alloy is about half nickel, quarter cobalt, less than 10 per cent iron. Other constituents include chromium and titanium. Commercial production is practible; cost, necessarily, will be high.

Properties of the metal are so far superior to steel at elevated temperatures that fields of application have hardly been scratched. Dies, valve trim, and turbine blades are possibilities.

Correction

On Page 58, April POWER, the name of Yarnall-Waring was inadvertently omitted from the list of principal power-plant-equipment suppliers. This company supplied blowoff valves to the Dunn Sulphite Paper Co, Port Huron, Mich.

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Adjustable
SPROCKET RIM
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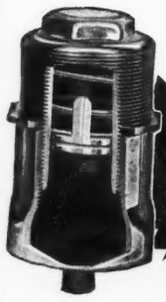
GREASE CUPS



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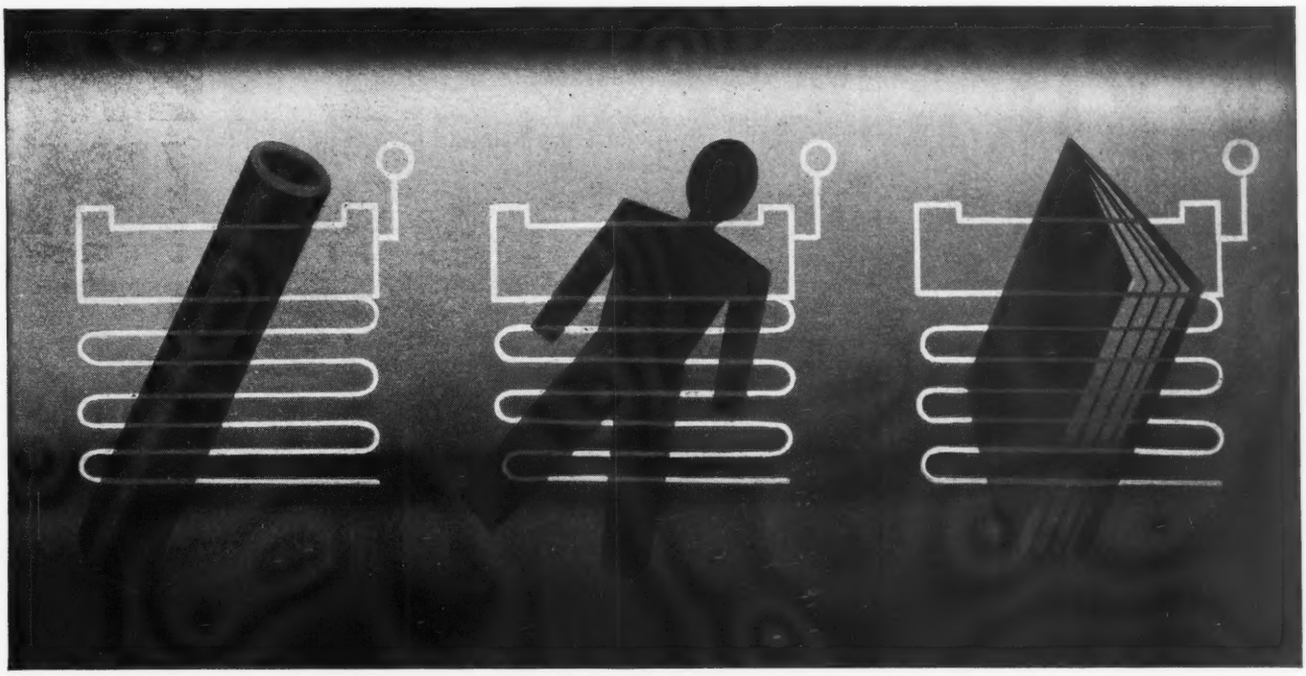

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There are three major services you receive, at no extra cost, with every pound of condenser or heat exchanger tube you buy from Scovill. Here are the three aids you get, each contributing to trouble-free service:

SERVICE IN METALS—consisting, first, of laboratory development of new alloys fitted for better and longer service under particular operating conditions. For example, a Scovill Copper Nickel Alloy has been found to give more economical service under certain conditions of operation even though the per pound cost of the Copper Nickel is considerably higher than the Admiralty Metal previously used in many such cases. Then there's the constant vigilance of inspection of raw materials, and of finished tubes. You can expect uniformly high quality on every shipment from Scovill.

SERVICE IN MEN — Scovill's engineering representatives who also serve you in two ways. When they first contact you, they study the conditions under which you operate, and carefully prescribe the alloy that will serve you longest, with least trouble. Then, after the tubes are installed, they don't forget you—they maintain a field staff to check on how the tubes are operating in service. If anything is wrong, they go to work to find and root out the trouble. A case in point — a customer thought his troubles were due to use of the wrong alloy. Scovill engineering representatives helped him cure the troubles by merely using a different method of installation.

SERVICE IN MANUALS—new reservoirs of knowledge about condenser and heat exchanger tubes have accumulated since the earlier editions of Scovill's manuals were published. We have just published a new edition of the 68-page "Condenser Tube Booklet." It is free for the asking. Send today for your copy. Address 13 Mill Street, Waterbury, Connecticut.

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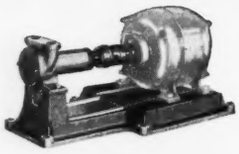

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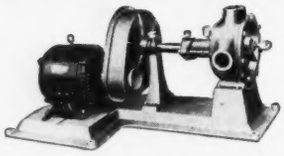

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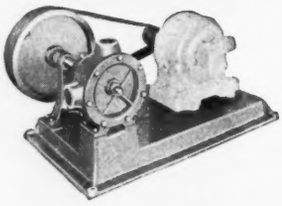

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CEDAR FALLS, IOWA

Fred Witsell, Toledo Edison, Elected NDHA President

At the annual convention in French Lick Springs, Ind., May 14-17, the National District Heating Association elected Fred Witsell, of Toledo Edison Co, as president. Other officers include L S Phillips, New York Steam Corp, and J M Arthur, Kansas City.

Meter testing and maintenance, sales and organization problems, aids to customers in the proper utilization of district steam, were topics of discussion in several committee meetings. The annual operating statistics report presented a very complete review of steam sales, costs, fuel required, and increase in sales volume accompanied by a slight decrease in average rate per M lb.

Five points higher efficiency with a new oil-fired boiler at 8% lower cost for fuel was claimed by A W Weiters for an installation in Toledo using local refinery residue. Effect of temperature controls on steam-generating-plant pressure and load was the subject of a study by R C Hine. In only a few instances, he said, have customer controls produced serious operating difficulties in the steam-producing plant.

A stack-emission symposium showed that very few of the companies have done any work on dust emissions. Several tests presented, however, enabled characteristics of the types of collectors to be estimated.

Standard degree-day figures for use of the member companies, listed in the Research Committee report, differ somewhat from other similar data. The report itself makes full explanation for selection of these more accurate values.

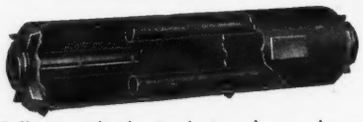
On the subject of steam-jet and steam-turbine-driven refrigeration compressors for air conditioning, R L Mumford of New York Steam Corp presented figures on four recent jobs, all department stores, which showed appreciable benefits to both consumer and supplier from use of steam instead of electric power. Low load factor, about 5%, he said, fits in better with the steam company low summer demand than with the electric load curve.

Actual records of operation of 384 buildings of all types were coordinated and curves drawn for estimating heating-steam requirements in a report given by Earle Schultz and J C Butler. Even with certain unavoidable non-uniformity in the method of calculating building volumes, several authoritative opinions held that these data were by far the most comprehensive and useful yet devised. The full report, of use to those having responsibility for building-heating estimates or operating efficiency, will shortly be published by the NDHA, 1231 Grant Bldg, Pittsburgh.

Union Electric Plans New Plant in Illinois

Union Electric Co of Illinois has retained Stone & Webster Engrg Co to design and construct a new power plant at Venice, Ill. Initial installation will consist of two high-pressure, high-temperature, 40,000-kw turbine-generators and two 360,000-lb-per-hr boilers, with condensers, switchgear, and other auxiliaries.

2 NEW MAXIM SILENCERS



Following the basic design shown above, two new Silencers have been developed by MAXIM to provide greater flexibility in meeting an increasingly wide range of silencing problems.

The new and improved MUI is built for use on all types of internal combustion engines, on reciprocating steam engine exhausts, as well as on compressor intakes. Its extremely high degree of silencing efficiency makes it particularly applicable for use where maximum noise attenuation is desirable.

The MUC is a more compact silencer, embodying the same basic design and intended for the same general applications as the improved MUI but developed to fill the need for a more compact Silencer Unit at lower price.

Write for details.

THE MAXIM SILENCER CO.

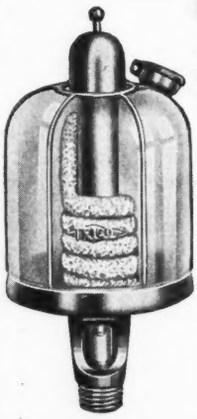
92 Homestead Ave. Hartford, Conn.

New!!

TRICO

Unbreakable

WICK-FEED OILERS



- Visible Oil Supply
- Automatic Operation
- Streamlined Design

NOW—replace your old-fashioned trust-to-luck wasteful oil cups that usually run dry when least expected, with this visible ultra-modern WICK-FEED Oiler.

Feed is automatic and positive — at each filling the bearing is flushed momentarily and thereafter the wick feeds oil to the bearing by capillary action. No adjustments are necessary. Dirt and sediment cannot enter bearing. Beautifully finished in bright cadmium-plate.

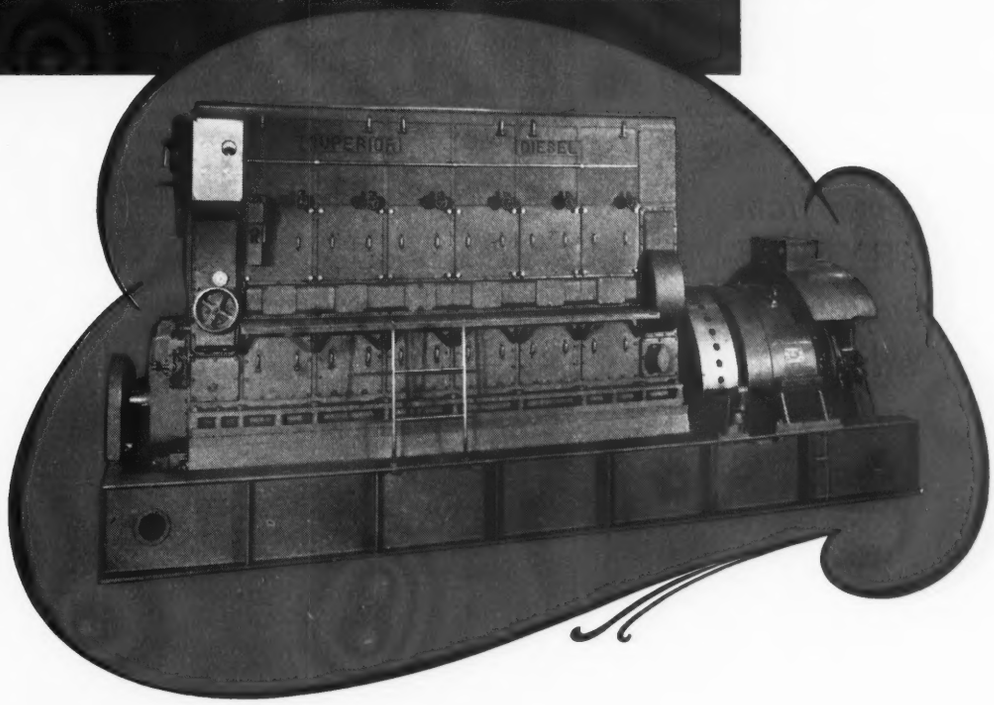
Available in five styles; in one, two and four oz. capacities.

WRITE FOR BULLETIN #27

TRICO FUSE MFG. CO., Milwaukee, Wis.

In Canada: IRVING SMITH LIMITED, Montreal

When you invest in a Diesel...



MARATHON V.E.P. OIL

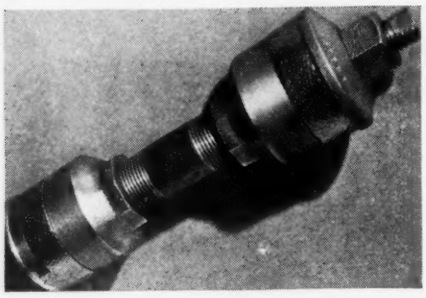
will definitely PROTECT your investment!

● Another fine Diesel installation . . . a satisfied customer . . . a contented engineer . . . a sound investment—*yet all so dependent upon a scientifically correct lubricating oil.* It is true, of course, that all types of prime movers require satisfactory lubrication; but Diesels, due to extreme bearing pressures and high cylinder temperatures, require more than just "A Good Oil". They need MARATHON V.E.P. Oil . . . developed and refined by the Ohio Oil Company . . . used and endorsed by Diesel engine manufacturers and operators. To protect your Diesel investment, investigate the exclusive characteristics of MARATHON V.E.P. Oil . . . It will *prolong the life and efficiency* of your valuable units.

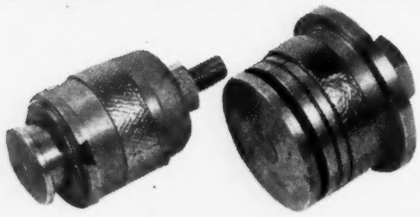
Write today for complete, factual V.E.P. details.

MARATHON
BEST IN THE LONG RUN

THE OHIO OIL COMPANY
INCORPORATED
GENERAL OFFICES — FINDLAY, OHIO



PROTECT YOUR PLANT
from
COSTLY SHUT-DOWNS
by Stopping Tube Leaks Quickly, Easily . . . with
HARDIE
MADE-RITE PLUGS



With HARDIE MADE-RITE PLUGS on hand for emergency use, you can stop leaky boiler tubes, condenser tubes and pipe lines instantly, effectively. Service can be resumed quickly without delays.

These modern, simple, inexpensive plugs will keep your equipment going until such a time as it is convenient to make permanent repairs. They'll pay for themselves on the first leak!

SO EASY TO USE

Just insert a Made-Rite in a leaky tube, pull up on a nut and the leak is stopped by inside expansion of the packing ring in the tube.

TYPES FOR ALL TUBES

No. 1 Rod Type for fire tube boilers accessible at one end only; plug heads provided for both ends of tube are tightened at one end to seal front and rear ends at the same time. Can be installed under pressure. No. 2 For fire tube boilers and condensers where back connections are convenient to reach. Will stop leaks between tube and tube sheet. No. 3 For water tube boilers. Simple to install, effective.

A FEW TYPICAL USERS

Both large and small plants in scores of different industries are saving time, money and trouble with these plugs—among them, New York Telephone Co., Du Pont, R. H. Macy (world's largest department store) and several government departments.

MAIL COUPON TODAY
FOR COMPLETE DETAILS

HARDIE MADE-RITE PLUG CO.
1742 Second Ave., New York, N. Y.

Gentlemen: Kindly send your **FREE** illustrated booklet on Hardie Made-Rite Plugs.

Name .....

Position .....

Company .....

Address .....

Moan Organizes Power Activities

A program to coordinate protection of the nation's power generation and transmission facilities, as an aid to national defense, has been initiated under the leadership of E G Moan, prominent member of the National Association of Power Engineers. Mr Moan, a power engineer associated with the District of Columbia Penal Institutions and a special deputy president of the N A P E, has enlisted the approval and assistance of various government agencies, including the National Power Policy Committee.

Briefly, this program aims to enlist the voluntary aid of power engineers in quelling any subversive influences, that may spring up during the period of strife in Europe, which might endanger the operation of power plants and transmission facilities. Special deputy Moan, Box 25, Lorton, Va., has volunteered to receive all inquiries and correspondence pertaining to the work of the National Coordination of Power Engineers.

OBITUARIES

JESSE B WILLIAMSON, assistant secretary of the Federal Power Commission, died suddenly on May 1, of a heart attack. Mr. Williamson had been assistant secretary of the commission since September 22, 1938. Previous to that time he had served for three years in the Division of Insolvent Bank Reports, office of the comptroller of the Currency in the Treasury Dept.

DAVID BARKER RUSHMORE, 66, chief engineer of the power and mining department of the General Electric Co for 20 years before his retirement in 1925, died on May 6 following a fortnight's illness. Mr Rushmore was born in Westbury, L. I. in 1873, and attended Friends Academy, Swarthmore Prep, and Swarthmore

David B Rushmore

College, where he won the Joshua Lippincott Fellowship. Following his graduation in 1894 from Swarthmore, he worked as an electrical engineer for the Westinghouse Electric & Mfg Co in Pittsburgh, the Royal Electric Co in Montreal, and the Stanley Electric Co in Pittsfield. In 1905 he entered the employ of the General Electric Co, and stayed with that company until his retirement.

Save Air—Save Dollars
WITH
ROCKWELL
BLAST GATES

Threaded Slide Type

Flanged Slide Type

For Low Pressure Air

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Slide Type
Butterfly Type
Wafer Butterfly Type
Kwikleen Type

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Write for catalog No. 3760

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W. S. ROCKWELL COMPANY
50 CHURCH ST., NEW YORK

"STANDCO"
PILLOW BLOCKS

Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth. It can be depended on for long, trouble-free service.

Fig. 32

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Write for Bulletin

STANDARD
PRESSED STEEL CO.
JENKINTOWN, PENNA.

Boston
Detroit
Indianapolis
Box 577
Chicago
St. Louis
San Francisco

AS *Easy* TO GET AS THEY ARE *Easy* TO INSTALL

● Not far from your plant is an ELECTRUNITE distributor — with complete stocks of these money-saving, electric welded boiler tubes. He may be just around the corner, several blocks away or in a nearby city — but, in any event, he can deliver the tubes you need in a hurry, and that's important when a boiler is down for repairs and you're suffering for lack of boiler capacity. He is in business for one purpose — and that is to supply you with tubes when you need them.

Now, about the tubes he will send you —ELECTRUNITE Boiler Tubes. Their records of service in every type of boiler have proved beyond any doubt that they are SAFE and SOUND. Acceptance and approval by central stations, boiler manufacturers, railroads, insurance companies and codes further attest their dependability. Their ease of installation has resulted in reports of up to 20% savings in installation costs. They expand and bead easily —make tight joints — speed up installation — because they are consistently uniform in diameter, wall thickness, concentricity and ductility. And their fine, smooth, scale-free surface inhibits corrosion.

Ask your ELECTRUNITE distributor for literature—then call him when you need tubes. If you don't know his name, write us. Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

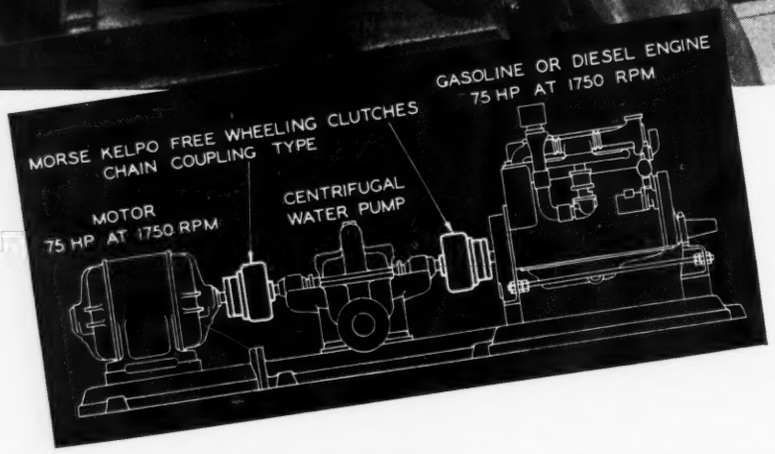
Republic **ELECTRUNITE**

REG. U. S. PAT. OFF.

ELECTRIC RESISTANCE WELDED BOILER TUBES

MORSE FREE-WHEELING CLUTCHES

CONSTANT SPEED AND NO SHUTDOWNS FOR THIS PUMP

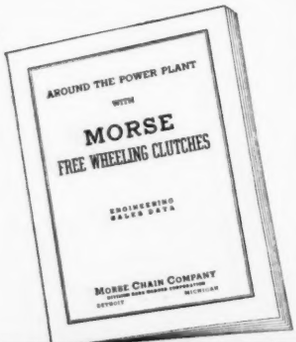


The above illustration shows another typical installation of Morse Free-Wheeling Clutches—as applied to a dual-driven centrifugal water pump.

The pump is normally driven by the electric motor, while the engine is a standby in case of electric power failure or motor trouble. In such an emergency, the engine can be started automatically with no loss of time. No labor is required for the changeover.

At no time can one driving unit drive the other, yet both are always connected and ready to take up the load when necessary.

No power is wasted. There's no danger of damage to the idle prime mover.



Send for Clutch Engineering Bulletin

"Around the Power Plant with Morse Free-Wheeling Clutches" contains helpful, practical data you should have—interesting diagrams of typical power plant applications. Write for your copy today!

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY, ITHACA, N. Y. • DIVISION BORG-WARNER CORP.

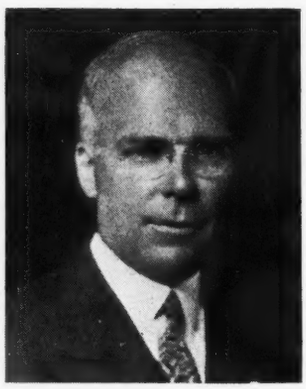
WALTER S RUGG, 74, retired vice-president of the Westinghouse Electric & Mfg Co, and widely known throughout the electrical industry, died April 25 in New York. Following graduation in 1892 from Cornell University, he entered the student engineering course at Westinghouse. Three years later he went to the Chicago office as district manager, later transferring to the sales force. From 1901 to 1917 he was in the New York offices, the last 8 years as manager. In 1922 he became general sales manager of the company and was elected a vice president in 1925.

EDWIN MERRITT HOOKER, 55, supervisor of the industrial section of the power and heating bureau of the Buffalo Niagara Electric Corp, died in Buffalo General Hospital April 6. He had a large part in planning the electrification of the industrial plants in the Buffalo area. Mr Hooker joined the Buffalo General Electric sales department 31 years ago.

A WHITON VENNEMA, 53, mechanical superintendent of the Manhattan Rubber Mfg Div, Raybestos-Manhattan, Inc, died at his home in Ridgewood, N. J. March 23. Mr Vennema graduated with the Class of '09 from Stevens Institute and had been with the company for 31 yrs.

PERSONALS

ROBERT M GATES formerly vice-president in charge of sales of Combustion Engrg Co, has been named president of



Robert M Gates

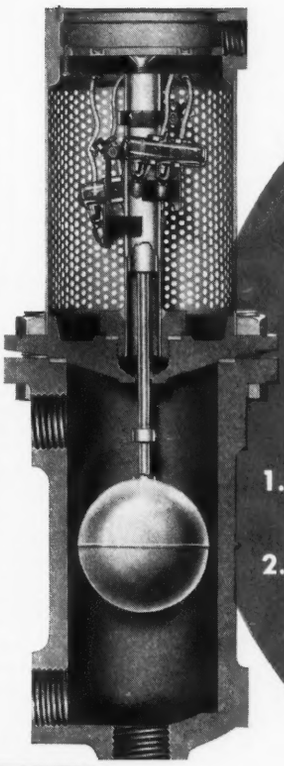
the Air Preheater Corp, New York, N. Y., effective May 1st. He will also continue as vice-president of the Superheater Co.

NORMAN L DEUBLE is now associated with Copperweld Steel Co, Warren, Ohio, as assistant to the vice-president. He is a graduate of the Case School of Applied Science. Mr. Deuble was previously with the Republic Steel Corp, and has also been associated with the Central Alloy Co and United Alloy Steel Co.

ROBERT S PEARE, president and general manager of the Maqua Co, printing and engraving firm affiliated with the General Electric Co in Schenectady, has been named manager of the publicity department of General Electric. He succeeds Chester H Lang, who becomes manager of apparatus sales for the company.

We originally designed MAGNETROL for our own use.

We have used all types of boiler water level controls over a period of years as an integral part of our complete condensation return and boiler feed systems. Naturally, we experienced the same operating problems that you now have. We wanted greater dependability, greater safety, and less replacement and maintenance cost. With this as our goal, and starting from scratch with a thorough knowledge of the weaknesses of all existing controls, we built the Magnetrol which had no "weak spots". With its use on our systems, establishing and proving the fundamentally sound operating principle, we decided to make the Magnetrol available to every steam boiler user with a water level control problem.



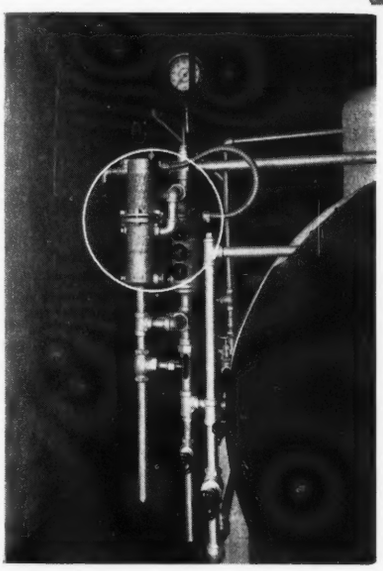
Now you can have BOILER WATER LEVEL CONTROL

1. *With* DEPENDABLE FEED REGULATION PLUS ABSOLUTE BOILER SAFETY
2. *Without* HAZARD OF STUFFING BOX, BELLOWS OR ANODE FAILURE

SCHAUB

MAGNETROL

PAT. PEND. TRADE MARK



Installation photo of "Magnetrol" showing it cross-connected to a conventional water column.

THE MODERN INFALLIBLE BOILER PROTECTION

Different than any type of boiler water level control ever designed Magnetrol has no weak spots. It is engineered to a "new high" in dependability and is guaranteed against operation failures.

An idea of the simplicity of construction is gained from the fact that bellows, stuffing boxes, packing, and rotary shafts have all been eliminated. These parts that contribute to unreliable operation are replaced by a simple, positive magnetic switch action that is the modern answer to dependability.

You can have this safety, this maintenance economy, this modern control for your boilers—you can replace with Magnetrol now and get positive protection against water level dangers—you can save boiler water level control money that was never possible before by ending service and replacement grief with its attendant costs. Every installation of the Magnetrol carries a five year operating guarantee.

The Magnetrol is totally unaffected by temperature or pressure because the switching mechanism is entirely out of the temperature and pressure zones.

5-POINT LIQUID LEVEL REGULATION

One of the important features of the Magnetrol is its five-point regulation—it has a low water cut-off—it has a high water cut-off—it has low water alarm—it has high water alarm—and it gives you pilot pump control (for either motor or steam drive).

GET ALL OF THE IMPORTANT DETAILS

If you haven't a Magnetrol you haven't the safety, the economy, the dependability that you should have—it's important to you to know all of the facts—it's to your benefit to let Magnetrol solve all of your boiler water level control problems—write now—let a Schaub engineer show you why it's the finest instrument of its kind.

●We make a Magnetrol to control liquid levels in open tanks. ●We make a Magnetrol to control the levels of Freon, Methyl Chloride, Ammonia and Carbon Dioxide in refrigeration systems. ●We make a Magnetrol for controlling liquid levels in pressure vessels and tanks. ●We make the ONE instrument (a Magnetrol, of course) which has proved successful in the liquid level control of Dowtherm boilers—an instrument that has proved its practicality for use in applications where extremely high temperatures are encountered.

FRED H. *Schaub* ENGINEERING CO.
325 W. Huron St. Chicago, Illinois

DESIGNERS AND BUILDERS OF SCHAUB CONDENSATION RETURN AND BOILER FEED SYSTEMS

WRITE FOR BULLETIN NO. 140

SCHAUB SYSTEMS

THIS PACKING
IS BUILT ON
THE OIL CAN PRINCIPLE

PALMETTO
for steam, air, hot fluids
PALCO
for water
PELRO
for solvents, oils
CUTNO
for alkalis
SUPER CUTNO
for acids

As long as a film of lubricant is maintained between packing and metal, there can be no wear of either. Every fibre of Greene, Tweed Packing is impregnated with a special lubricant that resists the destructive forces of the particular use. The packing remains soft, lives longer and does not wear the shaft.

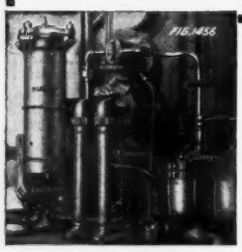
YOU TEST IT

Send for a working sample. Test it for tightness, long life and minimized shaft wear. You will say it's the best packing you have ever used.

GREENE, TWEED
SELF-LUBRICATING
PACKINGS

GREENE, TWEED & CO., 101 Park Ave., New York, N. Y.

STOP DIRT
BEFORE IT STOPS YOU



ABOVE—Nordberg Diesel at Hominy, Okla., with Nugent By-Pass Filter on lube oil line and Nugent Duplex Filter on fuel oil feed line. LOWER RIGHT—Nugent Batch Oil Filter serving turbines in Delray Station of the Detroit-Edison Co.

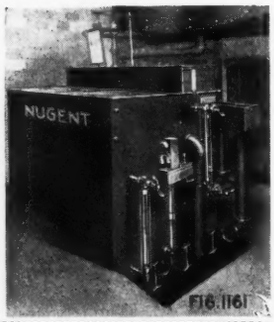
NUGENT TRADE MARK

Use Nugent Filters!

FOR DIESELS . . . OIL ENGINES . . . GAS ENGINES . . . COMPRESSORS . . . TURBINES . . . OIL BURNERS . . . ETC.

There is a Nugent Filter for Every Purpose!

CUSTOMERS report stopping as much as 75% of ALL OPERATING TROUBLE by equipping Diesels, oil engines, etc. in accordance with our recommendations. Dirt in fuel oil lines can stop you cold instantly; dirt in lube oil lines may stop you quickly and certainly will stop you for repairs long before they would otherwise have been necessary. Get our recommendations for your own protection. Write.



WM. W. NUGENT & CO., INC.
Established in 1897
402 Hermitage Ave., Chicago, Ill.

SEND ME

Wm. W. Nugent & Co., Inc.
402 N. Hermitage Ave., Chicago, Ill.

Please send me literature and information about the following Nugent specialties: ☐ Diesel Engine Fuel Oil Filters. ☐ Diesel Engine Lube Oil Filters. ☐ Turbine Oil Filters. ☐ Sight Feed Bearing Oilers. ☐ Telescopic Eccentric Oilers.

Name .....

Company .....

Address .....

J G Gidley has been appointed manager of sales, Schenectady Section, Turbine Div, General Electric Co. Mr Gidley will be responsible for the sale of all turbines manufactured in Schenectady. He succeeds R S Neblett, who has been assistant manager of the Turbine Div since the middle of 1939.

Alfred H Schoellkopf, president of the Niagara Hudson Power Corp, was presented with a 25-year service pin at the fourth annual dinner of Old Timers of the Niagara Power industry on April 4. Various members of the Niagara Power organization addressed the group, and other awards were made.

Alexander Norden, Jr, has been elected vice-president of the L S Brach Mfg Co, effective March 1, 1940.

Harry N Hayes has been appointed general sales manager of the Coffing Hoist Co, Danville, Ill. After becoming affiliated with this company he acted as manager of numerous districts throughout the country.

Hayes Parsons has been appointed sales manager of the Link-Belt Speeder Corp. For the past several years Mr Parsons has represented the Speeder Machinery Co, and, after the consolidation, the Link-Belt Speeder Co. in the Seattle district.

BUSINESS ITEMS

Chain Belt Co, Milwaukee, Wis., announces several changes in personnel: Thomas E Cocker has been appointed manager of the Detroit district office. He succeeds G A Gunther. Mr Klemme will succeed Mr Cocker as manager of Buffalo district office. Mr Robert Potter, member of the home office sales organization in Milwaukee, has been transferred to Pittsburgh office as an assistant to Mr Gayle Sherratt, district manager.

Foster Wheeler Corp, 165 Broadway, New York, N. Y. announces appointment of P W Foster, Jr, as manager of Steam Div. Martin Frisch, formerly chief engineer of the Steam Div, has been appointed chief engineer of Foster Wheeler Corp.

National Association of Fan Manufacturers at its annual meeting in Chicago, April 11, elected E Szekely, president; H Mathis, vice-president; and L O Monroe, secretary-treasurer for the coming year.

Manning, Maxwell & Moore, Inc, Bridgeport, Conn., announce transfer of R F Heath from the Houston territory to the New Orleans district, which was formerly covered by Jack Schuyler.

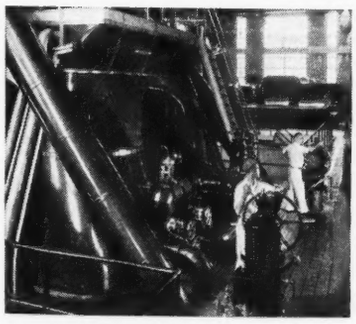
Western Precipiation Corp, Los Angeles, will open sales and engineering office at room 1137, Marquette Bldg, Chicago, Ill. A W Robinson, associated with Western Precipitation for many years, is in charge of operations in the central states.

Acheson Colloids Corp, Port Huron, Mich., announce that, effective May 1, Ray-

To generate 345,000 kilowatts an hour...

FORD
ROUGE POWER PLANT
uses COAL!

The main switchboard through which electric energy from Rouge Power Plant No. 1 goes to thousands of motors throughout the great plant. To keep *those motors running, Ford uses dependable, economical coal.*



Operators opening the valves that start one of the huge turbo-generators—the two largest of their kind in the world. The No. 1 Power Plant at Rouge at present uses 2500 tons of coal a day.

RATED as the greatest industrial power plant in America, the battery of high-pressure boilers at Ford's Rouge Power Plant No. 1 is fired 95% by COAL.

Power supply for so huge a plant must satisfy three basic requirements . . . DEPENDABILITY . . . EFFICIENCY . . . ECONOMY . . . the keynote of all Ford methods and products.

The satisfactory answer here—as in so many industrial power and heating plants of all sizes—is COAL.

Bituminous mines in "The Coal Bin of America" are equipped to give you *uniform* shipments of coal conforming to your exact specifications as to B.T.U., ash softening temperature, high or low volatility, ash content, grindability.

Served by Chesapeake and Ohio, products of these mines are delivered speedily, carefully, and on time. The railroad likewise offers, free, to coal users the help of trained Fuel Service Engineers who have aided many an industrial concern to solve its fuel problems.

For information or assistance with fuel problems, write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, O.

CHESAPEAKE AND OHIO LINES

PHOTOSWITCH SMOKE ALARM
Increases Fuel Economy — Avoids Smoke Nuisance

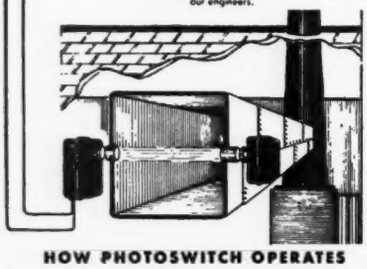
WATCH YOUR SMOKE—

PHOTOSWITCH
The Electric Eye

SMOKE ALARM CUTS FUEL COSTS BY CONTROLLING SMOKE IN THOUSANDS OF POWER PLANTS.

Used by factories, hotels, hospitals, public utilities, institutions, universities, railroads, steamboats, etc. throughout the world.

PHOTOSWITCH INCORPORATED manufactures photoelectric controls and electronic products for all industrial purposes. Refer your electronic control problems to our engineers.



HOW PHOTOSWITCH OPERATES

Photoswitch Control and Light Source are aligned on opposite sides of the flue or breaching, the light beam projecting to the lens of the control. When the smoke passing through the flue exceeds the density at which the tamper-proof sensitivity adjustment has been set, PHOTOSWITCH flashes a signal to boiler room attendant as a warning that combustion conditions require correction.
The PHOTOSWITCH DENSOMETER shown above wired to the output of the control continuously indicates the smoke density and flashes a red signal light when smoke is excessive. Complete smoke alarm installations can be made quickly and easily by your own mechanic.

RUGGED • LOW IN COST • GUARANTEED

FOR VALUABLE INFORMATION ON FUEL ECONOMY MAIL COUPON

PHOTOSWITCH INCORPORATED Cambridge, Massachusetts
Send detailed information on "Fuel Savings with PHOTOSWITCH."

PHOTOSWITCH INCORPORATED
CAMBRIDGE • MASSACHUSETTS

mond Szymanowitz, technical director, and his staff, will be at 1019 Broad St, Newark, N. J.

WARD LEONARD ELECTRIC Co, Mt Vernon, New York, has opened a branch office in Baltimore, Md. Wilson K Winbigler is in charge of the office, which is in the Hearst Tower Bldg.

MORSE CHAIN Co, Ithaca, N. Y. announces the opening in Houston, Texas, of a new branch office. This new branch, which will be at 1418 Polk St, will be in charge of Bob Koch, who comes to Houston from the home office at Ithaca.

ROLLER-SMITH Co, Bethlehem, Pa., Switchboard Div has been transferred to a recently acquired plant in Allentown, Pa. J E Bevan will be the manager with supervision over both manufacturing and engineering. W R Swoish, sales manager, will continue in charge of sales.

TURBINE PUMP DIV, ROOTS-CONNERSVILLE BLOWER CORP, Connersville, Ind., announces appointment of several new territorial representatives: Kent-Ervin Engrg Co, Builders Exchange Bldg, Minneapolis, are covering states of Minnesota and North and South Carolina. J T McKinney, 1122 Pointview St., Los Angeles, handles sales in southern California. Smith-Booth-Usher Co, Los Angeles, continues as company representatives. P J O'Meara Co, San Francisco, Calif, will promote turbine pump sales in northern California and most of Nevada. This will not affect E A McCallum, who has been in charge of the San Francisco branch office for many years. L S Pawkett & Co, San Antonio, Texas, will promote sales throughout south central Texas. Power Machinery Co, 215 North Detroit, Tulsa, Oklahoma, is in charge of sales for that state. H K Wilson, St. Petersburg, Fla., is now in charge of sales for that state.

SENECA COAL & IRON CORP has changed its address from 17 Battery Place, New York, N. Y. to 90 West St, same city.

Corporate title of EISLER ELECTRIC CORP has been changed to Callite Tungsten

MEETINGS

American Institute of Electrical Engineers —*Annual Summer Convention, Swampscott, Mass. June 24–28. H H Henline, secretary, 29 W 39th St, New York, N. Y.*

American Society of Mechanical Engineers —*Semi-Annual Meeting, June 17–21, Milwaukee, Wis. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Society of Refrigerating Engineers—*27th Spring Meeting, Skytop, Pa., June 9–11. David L Fiske, secretary, 37 W 39th St, New York, N. Y.*

American Society for Testing Materials—*43rd Annual Meeting, Chalfont-Haddon Hall, Atlantic City, N. J., June 24–28. R E Hess, assistant secretary, 260 S Broad St, Philadelphia, Pa.*

National Association of Fan Manufacturers —*Summer Meeting, White Sulphur Springs Va., June 14. L O Monroe, secretary-treasurer, 5–208 General Motors Bldg, Detroit, Mich.*

Stoker Manufacturers Association—*Annual Meeting, June 6–7, Homestead Hotel, Hot Springs, Va. Headquarters Office, 307 N Michigan Ave, Chicago, Ill.*

You Are
The Judge and the Jury

"The Entirely Different Boiler and Engine Treatment"

In legal parlance, that's going some. In engineering, it's the "ne plus ultra."

In the "Court of Power-Wise Experience," SAND-BANUM has been universally cited for scientifically eliminating and preventing boiler and engine scale and corrosion. A 16-oz. can protects a 250 Hp boiler for 30 days.

Proof of "MORE POWER TO YOU", at lower costs, awaits your request.

AMERICAN SAND-BANUM CO., Inc.
9 Rockefeller Plaza
New York City

Install Tight Valves

1. EVERLASTING VALVES have a well-earned reputation for holding tight.
2. EVERLASTING VALVES deliver more Service per dollar invested.
3. THE EVERLASTING VALVE flows liquids faster than other types of valves.
4. The ULTIMATE or REAL cost per valve is more important than the INITIAL outlay.
5. THE EVERLASTING VALVE is needed in every kind of service where a DROP-TIGHT-SEAL is desired in handling Steam, Water, Air, Oil, Tar, Gas, Gasoline, Acids, Etc.

EVERLASTING VALVE COMPANY
Jersey City, N. J.

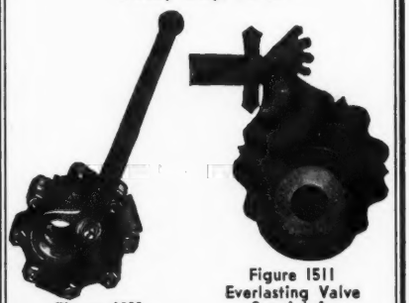


Figure 1000 Regular Everlasting Valve, Straight Lever, Screw Ends.

Figure 1511 Everlasting Valve Special for 600 Lbs. Pressure

Use Everlasting

THERE IT IS . . .
without a doubt

Above is shown a reproduction from an actual unretouched color photograph which illustrates the appearance of the gauge glass from directly in front.

BECAUSE the liquid level in a "PYREX" Broad Red Line Gauge Glass is easy to see, from any angle and at greater distances, more frequent checking becomes a habit with boiler room attendants. Greater safety and efficiency is the obvious result.

The fused-in, permanent, broad red line produces a readily visible dividing line in the appearance of the gauge glass above and below the water level (see illustration). Either ordinary reflected light or rear illumination effectively reveals the exact liquid level.

Complete details on "PYREX" and Corning Gauge Glasses can be obtained from any of the leading steam and mill supply houses. Ask your dealer why these glasses are more efficient and more economical in the long run.

PYREX

Pyrex GAUGE GLASSES

BRAND CORNING GLASS WORKS, CORNING, N.Y.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.

ROTO Cleans Sharp Bends in Modern Boiler Tubes

★ FASTER —

Rapid-action 'trigger' on motor eliminates signalling delays. Puts the boiler back on the line hours sooner.

★ CHEAPER —

One-man operation eliminates helper and reduces cost of compressor operation.

★ BETTER —

Greater cleaning power of new design motor removes scale far more quickly and effectively.

It's no trick to cut down the diameter and length of a cleaner for straight tubes until it can negotiate the sharp curves found in the latest type boilers. But it's another thing to design a cleaner that removes the scale too.

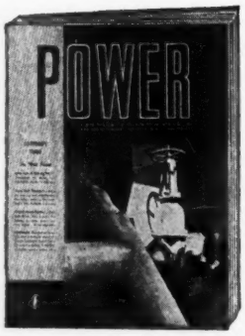
It takes a specialist to design a cleaner for curved tubes. In cooperation with leading boiler manufacturers, Roto engineers have designed a complete line of cleaners for the most modern curved tube boilers.

Roto cleaners offer time and money-saving features found in no other cleaners. If you have a difficult cleaning problem, it will pay you to consult Roto. We've been making tube cleaners since 1910. Write.

SEE OUR ADV. IN SWEET'S CATALOG

The ROTO Company

145 SUSSEX AVENUE NEWARK, N. J.



COMING!

1. Radiant Heating—its present and future.
2. Engineering Data on 400 modern steam and hydro plants.
3. Combustion — principles and practice.
4. Handbook of mechanical transmission.

Read POWER Regularly

Corp. The new name was decided upon at a meeting of stockholders on April 2.

INTERNATIONAL DIESEL ELECTRIC CO, INC, 7 Dey St, New York, N. Y., announce formation of that company for conducting general power business. Company will specialize in unitized diesel electric installations employing Strong automatic control patents. Murray & Flood, engineers, have been engaged as consulting and management engineers. James R Shelton is president, and Chester F Strong is vice-president.

NORTH AMERICAN LIGHT & POWER CO announces election of Allen Van Wyck as president. Mr Van Wyck, who was formerly senior vice-president of the electric operating companies in the North American Group, has also been elected president of the Illinois Power Co.

TRICO FUSE MFG CO, Milwaukee, Wis., announces two appointments: Huie-Simmer Co, 103 Thomas Bldg, Dallas, Texas, as district representatives in Oklahoma, and L W Sloan, 408 Olive St, St Louis, Mo., as district sales representative in St. Louis, Mo., and vicinity.

MARLEY CO announces removal of its New York sales office to 2 Rector St. Home office is in Kansas City, Kansas.

FEDDERS MFG CO announces consolidation of sales of heating and air conditioning equipment into Air Conditioning Div, with E R Walker as manager. Offices are in Buffalo, N. Y.

Opening of branch office at 687 Boylston St, Boston, Mass., is announced by GENERAL CONTROLS CO. C W Marsh, sales engineer, will be in charge.

Suspension of High-Temperature Piping

(Continued from page 77)

minimum tensile strength of 48,000 psi and a 40% elongation in 2 in. at room temperature.

In every case the spread between stress for variable-support and the safe maximum stress is too small negatively and too large positively for safety. The expansion stresses, which might augment these stresses, would in most cases produce a decidedly unsafe condition. For an equal factor of safety, the use of more expensive pipe material with variable-support hangers could be replaced by less expensive material with constant-support hangers.

It is interesting to note that, except for Case d, the spread between actual and safe maximum stresses is less for the larger than for the smaller pipes.

Finally, the important fact should be noted that for an equal over-all height of 18 in. for variable-support and constant-support hangers, Case d, the variability of the former would be 100%.